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CALIFORNIA SEWAGE WORKS JOURNAL

Official Publication of the California Sewage Works Association

Vol. XIII :: 1941 :: No. 1

Minutes of Thirteenth Annual Fall Convention
At San Diego, California, September 15, 16, 17, 1940

★

Ohio River Pollution

★

Cannery Waste Studies
Industrial Wastes and City Administration

★

Trends in Sewage Treatment

★

Sewage Disposal Problems

Sacramento
Los Angeles
Escondido
Stockton
San Diego

★

Legal Aspects

Sewer Legislation
Storm Drain Maintenance

★

History of the California Sewage Works Association

AT THE
RICHMOND-SUNSET
SEWAGE PLANT
SAN FRANCISCO, CALIFORNIA

Bear Brand

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$FeCl_2$	Trace	

	Crystals	Solution
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SO_3 not over	....	0.5%

*Can be supplied in any specified concentration within indicated limits.

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Affiliated with the National Federation of Sewage Works Associations

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California Sewage Works Journal

Published by CALIFORNIA SEWAGE WORKS ASSOCIATION

The California Sewage Works Association is not responsible, as a body, for the supposed facts and opinions advanced in any of the papers, discussions or articles published in this Journal. Discussions of all papers is invited.

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ANNOUNCEMENT

The Thirteenth Spring Conference will be held in Santa Cruz, April 20-22. Be sure to note the dates on your calendar.

The program committee is now busy working out a program which should appeal to all members.

BE SURE TO SAVE THE DATES.

THIRTEENTH ANNUAL FALL CONVENTION
CALIFORNIA SEWAGE WORKS ASSOCIATION

San Diego, California

September 15-17, 1940

MINUTES OF THE MEETING

Sunday, Sept. 15

President Harold G. Smith assembled the group in the Colonial Room of the Hotel U. S. Grant at 6:45 P.M. Mr. A. L. Dopmeyer, U. S. Public Health Service, read a paper entitled, "Ohio River Pollution Survey, First Year's Work," prepared by Messrs. H. R. Crohurst and E. S. Tisdale, of the Public Health Service. The paper was supplemented by a film illustrating the many points of the paper.

The meeting then moved to the Gold Room for a dinner. A program was provided by the operators. A number of short talks with lantern slide illustrations were presented.

Monday, Sept. 16

President Smith called the Business Meeting to order as 9:50 A. M. Nominations for office were submitted as follows:

President . . . . . Harold F. Gray
First Vice-President . . . . . Fred D. Bowlus
Second Vice-President . . . . Carl M. Hoskinson
Secretary-Treasurer . . . . William T. Ingram
Member Governing Board, 1945, Albert J. Castro, Jr.

It was moved, seconded and carried that the report of the nominating committee be accepted.

As there were no further nominations, the President declared the nominations for President closed. It was moved, seconded and carried that the Secretary be authorized to cast a unanimous ballot for President.

It was moved that all remaining officers be voted en bloc. The President then closed the ballot and called for vote. Carried.

The Group recommended the appointment of A. L. Frick to the Board of Control.

The Secretary read the proposed amendments to the constitution, and it was moved, seconded and carried that the Amendments be passed.

The following reports were called for and given:

Membership . . . . . Jack H. Kimball
Finance . . . . . J. F. Smith
Publicity . . . . . John A. Clark
Legislative . . . . . Howard Jewell

The business meeting was then adjourned until Tuesday noon. The technical sessions were started, and the following papers were presented:

"Development of Cannery Waste Studies at Palo Alto, Calif."
Jack H. Kimball—Harold May

"Current Developments and Trends in Sewage Treatment."
A. J. Fischer
Discussion—Harold F. Gray

"Application of Present Sewage Legislation."
Homer F. Buckley

The meeting adjourned to lunch at which time Councilman A. Flowers of San Diego welcomed the Association to San Diego. President Smith responded.

F. Carlyle Roberts, Secretary-Treasurer of the Arizona Water and Sewage Works Conference, extended a word of greeting and invited all those who could to come to Safford, Arizona, October 4th, 5th and 6th.

The technical sessions resumed at 2 P. M. At this time, a moment of pause was given in memory of A. K. Warren, Chief Engineer, Los Angeles County Sanitation District, and charter member of the California Sewage Works Association, who passed away August 28, 1940.

Short discussions were given on the operators panel by Carl F. Tennant and F. Wayland Jones. The Secretary read a contribution by Bernard Rowntree, and Mr. A. E. Fiscus read a paper prepared by W. V. Skinner.

Papers were presented as follows:

"Proposed Disposal of Sacramento Sewage"—Prepared by Carl Hoskison, read by C. R. Blood.

"Electrolysis at Terminal Island Treatment Plant"—G. A. Parkes.
Discussion—Richard Pomeroy.

"Public Health Considerations Regarding San Diego County Sewage Disposal"—G. C. Zuckweiler.

"History of California Sewage Works Association"—C. G. Gillespie—E. A. Reinke.

There was a lively discussion from the floor on the above papers. The meeting adjourned at 5 P. M., to the Annual Banquet.

The Banquet, to which the City Engineers Department of the League of California Cities was invited, was marked by the appearance and short address of Commander H. S. Baer, U. S. N.

A fine entertainment was presented in "Ye Olde Time Vauderville," by a selected cast of San Diegans.

Tuesday, Sept. 17

The City Engineers and Street Superintendents Department of the League of California Cities and the California Sewage Works Association assembled at a joint breakfast. Mr. Elmendorf, Chairman of the City Engineers, asked Mr. Alfred Jones, Los Angeles County Surveyor, Mr. E. S. Gripper, District Engineer State Highway Department, and Mr. B. D. Phelps, Asst. City Engineer, San Diego, to give short discussions. Albert J. Castro discussed the work of the California Sewage Works Association Award Committee. The Committee recommended that no award be made for the year 1940.

Technical sessions resumed at 9:35 A. M. Papers presented were:

"Sewage Pumping Plant Operation"—F. A. Batty.

"Sewer Maintenance Problems"—Lyle Payton.

"Problems of Industrial Waste from the Standpoint of City Administration"—W. T. Knowlton.

Discussion—William T. Ingram, Albert J. Castro.

"Legal Aspects of Sewer and Storm Drain Maintenance"—Hugh McDonald—Read by Mr. Davis.

The meeting adjourned to luncheon. After lunch, President Smith called the business meeting to order.

The Secretary presented a report of the constitutional amendment committee.

F. Wayland Jones presented a report of the San Joaquin Section of the California Sewage Works Association.

The Secretary's report was read.

Adolph H. Koebig presented the report of the Auditing Committee.

Albert Castro presented a supplemental report of the Award Committee.

The Secretary read a report of the Sub-Committee on Schools for Operators, and Mr. C. G. Gillespie reported for the Sub-Committee on Certification of Operators.

Richard Pomeroy reported for the Committee on Design Practice.

Two resolutions were presented to the meeting. The first was a Resolution relative to National Defense. The second was relative to cross connections of sewage and water in sewage systems. Both had been previously approved by the Governing Board. It was moved, seconded and carried that they be adopted.

Mr. A. C. Beyer explained the proposed changes which were to be considered by the Federation of Sewage Works Associations. It was moved, seconded and carried that Messrs. Alexander Bell and J. F. Byxbee be sent a Resolution of Regret and Sympathy for their long illness.

The new officers were then installed and President Smith transferred the chair to President Gray.

After a brief address, President Gray adjourned the meeting at 1:45.

Respectfully submitted,

WILLIAM T. INGRAM, *Secretary.*

AUDITING COMMITTEE REPORT

This is to certify that the undersigned, the auditing committee for 1940, have audited the books and the financial report of the Secretary-Treasurer, Mr. William T. Ingram as reported by Mr. Ingram September 7, 1940, and find them to be correct. *Signed:* ADOLF H. KOEBIG, JR., *Chairman*
C. L. TOWERS; ALBERT CASTRO, JR.

REPORT OF AWARD COMMITTEE

The Committee on Awards begs to submit its Report and Recommendation concerning the Award of Merit for the year 1940.

On April 11, 1940, the Committee sent all eligible communities having a sewage treatment plant an announcement of the annual Award of Merit and invited these communities to enter their plant in the competition.

In the last week of May a second letter was sent out explaining more fully the basis of the Award and application for entrance.

In response three (3) declarations of entrance were received. However, all contestants failed to submit the necessary reports.

In view of these facts the committee obviously recommends that no Award be granted for the year 1940.

The Committee also recommends that the continuance of such a yearly award be studied by the Board of Directors of this Association.

Respectfully submitted, ALBERT CASTO, *Chairman.*

REPORT OF PUBLICITY COMMITTEE

Mr. President, Fellow Members of the California Sewage Works Association:

It is with much pleasure that your committee reports the splendid publicity which our organization is receiving in the San Diego papers during our convention in this city. Our thanks and appreciation must be expressed to Director and Publicity Committee Member B. D. Phelps for his good work in contacting the press and securing the services of their reporters to write up our activities.

The Spring Conference held last May at Avalon on Santa Catalina Island was also well publicized. Your committee prepared several pieces of copy for the papers of Avalon, Covina, Long Beach, San Diego, and Los Angeles.

All meetings of the San Joaquin Valley Group were written up in the papers of the various valley communities, largely through the efforts of Committeeman F. Wayland Jones.

Respectfully submitted,

PUBLICITY COMMITTEE,
JOHN A. CLARK, *Chairman.*

REPORT OF MEMBERSHIP COMMITTEE

The Membership Committee wishes to report the following changes in the membership during the year 1940:

Total membership January 1, 1940 . . .	268
Members resigned or deceased	11
Members delinquent in dues	33
New members	46
Total membership September 15, 1940 . . .	269
Subscribers to the C. S. W. A. Journal . . .	3

The Membership Committee strove to reduce the number of delinquent members by sending several notices reminding them that dues had not been paid. In all 250 first notices, 81 second notices and 34 third notices were sent, making a total of 365 letters to old members.

The program for obtaining new members was divided into three fields. The city engineers of 128 cities that have existing sewage treatment plants of some type were contacted by an individually typed form letter. The many benefits to be gained by joining the Association were explained in the letter. To point out the purpose of the Association, a copy of the Constitution and By-Laws was enclosed. The typing of these individual letters was made possible by the members of the committee who offered to do this work, as is was felt that a personal letter would be more effective than an ordinary mimeographed letter.

Twenty letters of this type were also mailed to Equipment and Material men who are connected with sewage treatment work.

Mimeographed form letters were sent to 62 Junior Engineers who have

been graduated in Sanitary Engineering from Stanford University and the University of California within the past five years.

A total of 212 letters were sent out to prospective members. Seven of the 46 new members can be credited directly to this effort.

JACK H. KIMBALL, *Chairman Membership Committee.*

REPORT, COMMITTEE ON SCHOOLS FOR OPERATORS

This committee, appointed by President Smith last spring, has conducted a series of regional conferences for water works and sewage works operators during the year.

On May 7, 1940, a communication was addressed to the Board of Directors requesting that the committee be given permission to conduct these regional conferences in lieu of the previously conducted training schools. At the Catalina meeting, the Board granted this permission and the committee proceeded with the organization of these regional groups. In some cases meetings were held jointly with water works and sewage works operators and in some some cases separate meetings were held for the two groups. The first meeting for sewage works operators was held at Santa Clara on June 27; 22 men attended the meeting. The next such meeting was held at Stockton on July 12, being a joint meeting with the water works group. In this case, 22 men attended. The next meeting was held at Santa Rosa on September 6; 16 men attended. A similar meeting at Fresno, October 10th, was attended by 29. A Sacramento meeting, held October 4th, was attended by 28 members.

Attendance at these regional meetings has been fair and the men who have attended have expressed a keen interest in the meetings held and the discussion which was conducted.

Nearly all of those attending the meetings expressed a desire to continue such meetings.

Where meetings were held jointly with water works and sewage works groups, the meetings were held as one group for the afternoon session and then separated into two groups, one for the water and one for the sewage in the evening. No attempt has been made to prepare papers or have a definite program at these meetings. They have been merely round table discussion of various subjects and problems in which the operators expressed an interest. In most cases it has been possible to visit treatment works during part of the meeting.

Some difficulty has been encountered in getting local people to assist in the organization of the meetings and to make necessary local arrangements for places to meet. This has been particularly true at Santa Rosa and Fresno. After the first meeting was held at Santa Rosa, the group displayed such an interest that several volunteered to assist with arrangements for future meetings.

Following is a resume of the financial status of the committee's activities: $25.00 was advanced by the Sewage Works Association and there has been subsequently collected $27.00 from those attending the meetings, making a total of $52.00. Expenses on postage, on notices and various other incidentals has amounted to $26.90, leaving a net balance of $25.10, of which $25.00 was advanced by the Sewage Works Association.

It is felt that the plan of operation on these regional conferences has been fairly successful.

The work is still in the experimental stage and while attendance at the meetings has been rather low it is felt that interest is being created and that a continuation of the plan will result in the permanent organization of a number of subsidiary groups throughout the State. Thus far, a total of 78 men have been contacted through these schools in the northern part of the State.

G. E. ARNOLD, *Chairman.*

OPERATORS' JAMBOREE

The meeting was attended by 75 members and guests—operators, maintenance men, engineers, and equipment men. Many of those present, being unable to be absent from their duties for the regular sessions, came specially for this meeting. Several prominent men were given the "pH test," including Messrs. Goudy, Gillespie, Stallings of Tucson, and Frick, Colonel Smith and others.

The following speakers gave short talks on maintenance problems:

A. E. Fiscus—Treatment plant maintenance, emphasizing sludge and gas control; A. A. Appel—Industrial wastes, with reference to treatment at source; V. W. Thews— Grease analysis at the treatment plant; W. J. Cobleigh—Sewer maintenance to prevent grease and sand from reaching pumping plants and treatment plants; J. L. Carey—Electrical maintenance increases efficiency of plants through modern equipment; H. R. Olney—Solving problems of odor and noise in a ventilating plant; W. E. Murphy—Manchester Pumping Plant—increased efficiency in a modernized plant; E. A. Magliocco—Explosive gas survey reduces danger of explosions in sewers and disposal plants.

Two important matters were considered, one pertaining to cross connections and the other referring to national defense measures for sewage collection and disposal systems. The group voted unanimously to refer these important subjects to the Association, with the recommendation that proper resolutions pertaining thereto, be adopted.

REPORT OF SEC'Y-TREAS. SAN JOAQUIN SECTION CALIFORNIA SEWAGE WORKS ASSOCIATION

In accordance with the provisions of the Constitution and By-Laws of the San Joaquin Section of the California Sewage Works Association, I herewith submit a report of the membership, activities, and finances of the Section.

The membership consists of twelve (12) paid up members and two (2) guest members.

There have been nine (9) meetings during the year, held in the following cities: Sacramento, Lodi, Manteca, Tracy, and Stockton.

There has been very fine attendance at each meeting, and there has been a great deal of knowledge gained from the speakers and the programs presented.

Balance on hand September 14, 1939	$2.25
Income during year	3.50
Total	$5.75
Disbursements for stationery	4.50
Balance on hand	$1.25

Respectfully submitted, F. WAYLAND JONES, *Secretary-Treasurer.*

REPORT OF COMMITTEE ON DESIGN PRACTICE

The Committee has gathered some data on plain sedimentation tanks. From these data a chart has been prepared that presents certain factual information which, it is believed will be of general value to anyone interested in sedimentation as such. (See Pages 13 and 14)

RICHARD POMEROY, *Chairman.*

DESIGN AND PERFORMANCE DATA ON SOME SEPARATE PRIMARY SEDIMENTATION UNITS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
ONTARIO	20'x45'x6-9" + Sump RECT.	52,000	END	18' ACROSS END OF TANK	TRAVELING BLOWER TO TIPPING TROUGH	HARDINGE	1.00	2.50	3.0	5.0	1100	EACH HOUR	5 MIN.			NO	YES	17° TO 22°	NO WASTES WHICH AFFECT SEDIMENTATION	PRESENT TANK IS CONSIDERED TOO SMALL, ENLARGEMENT IS PLANNED
SEAL BEACH	12'x18'x12' RECT.	21,600	THROUGH BAFFLES AT END	12' WEIR AT END	TRAVELING AIR SKIMMER	TRAVELING SCRAPER	0.36 AT NOON. 1 TEST		1.4			TWICE DAILY	1½ HR. MORNING 1 HR. EVENING			SOMETIMES	YES		NONE	
EL CAJON	20' DIA. S.W.D. 6'-0"	18,800	14' WEIR BAFFLES 2' BELOW SURFACE	14' WEIR	DORR AUTOMATIC	DORR	0.144	0.195	2.3		460	ONCE DAILY	15 MIN.			NO			NONE	SEWAGE PUMPED IN INTERMITTENTLY AT 400 G.P.M.
PALO ALTO	55' DIA. DEPTH 7.5' TO 9.6'	151,000	HORIZONTAL PORTS SUBMERGED 3'-6" ALONG PERIPHERY OF 45'	OPPOSITE INLET ALONG PERIPHERY OF 45'	HARDINGE	HARDINGE	1.63	3.17	1.15	6.0	688	BY GRAVITY TO PIT EVERY 2 HOURS EXCEPT CANNERY SEASON	1 MIN. TO FILL 510 GAL. PIT	21.2 TO 1.58 AT NOON STRONGEST SEWAGE	2.97 TO 136 24 HR. COMPOSITE	MOST OF SLUDGE ON TOP IN CANNERY SEASON	NO. IT CAUSED RISING OF BLACK SLUDGE IN EARLY MORNING	18° TO 25°	CANNERY SEASON TRIPLES SLUDGE PRODUCTION, MOST OF WHICH HAS TO BE RAKED OFF OF TOP	B.O.D. REMOVAL: 30.5 TO 21.5 SOLIDS AND B.O.D. ARE HIGHER IN CANNERY SEASON. BUT PERCENT REMOVALS ARE NEARLY CONSTANT
HUNTINGTON BEACH	30' DIA. DEPTH 7'	37,500	CENTRAL	PERIPHERAL WEIR 94'	DORR	DORR	0.22	0.80	1.10	5.0	310	FOUR TIMES DAILY	15 MIN.			NO	YES	23° IN SUMMER	OIL WASTES TROUBLESOME	VISUAL SLUDGE AND SUPERNATANT OUTLETS DESIRABLE
BURLINGAME	2 UNITS 15'x68'x9' RECT.	680,000 EACH UNIT	END WEIR 15'	END WEIR 15'	COLLECTED BY RETURN OF CHAIN DRIVEN SLUDGE COLLECTORS	CHAIN DRIVEN SCRAPERS 2' PER MIN.	0.50 EACH UNIT	0.75 EACH UNIT	2.42	8.0	490	THREE TIMES DAILY	1 HOUR			NO	NO		NONE	
SAN LEANDRO	65' DIA. DEPTH 9'-6"	236,000	CENTRAL THROUGH 30" PIPE SURROUNDED BY BAFFLES	PERIPHERAL WEIR 205'	MECHANICAL ROTARY WITH WATER SPRAYS DRIVING SKIMMINGS TO COLLECTOR AT EDGE	DORR	SUMMER 0.50 WINTER 0.65	0.80	7	18	170	BY GRAVITY TO 2850 GAL. PIT TWICE DAILY	40 MIN TO FILL PIT		621 TO 62	VERY LITTLE	YES	17° TO 21°	SPINNACH AND PEACH CANNING AFFECT OPERATION, INCREASE SUSPENDED SOLIDS IN EFFLUENT. SCUM INCREASED	SLUDGE SOLIDS 6.6% DYE TEST SHOWED DETENTION OF 34 TO 62 MIN. SKIMMER CAPACITY SHOULD BE INCREASED
RICHMOND SUNSET SAN FRANCISCO	2 UNITS 33.5'x100' x10' RECT.	250,000 EACH UNIT	END. THROUGH WELL BAFFLED OPENINGS	4 FLUMES 25' LONG EXTENDING BACK FROM END OF TANK WITH NOTCHED WEIRS	WATER SPRAYS DRIVE SKIMMING TO INFLUENT END AND AROUND BAFFLES TO TROUGH	STRAIGHT LINE CHAIN DRIVEN	3½-4 EACH UNIT	6½-7½ EACH UNIT	0.75	3	1120	BY GRAVITY TO THICKENING TANKS FOR A TOTAL OF 5-6 HOURS DAILY			310 TO 65	RARELY. NO TROUBLE	RECEIVES ELUTRIATE FROM DIGESTED SLUDGE	19° TO 22°	NONE	SEDIMENTATION PRECEEDED BY MECHANICAL FLOCCULATION. SLUDGE VOLUME 80 000 GALS. PER DAY - 2.8% SOLIDS B.O.D. REMOVAL 220 TO 105

DESIGN AND PERFORMANCE DATA ON SOME SEPARATE PRIMARY SEDIMENTATION UNITS

LOCATION	1 DIMENSIONS TO WATER SURFACE	2 VOLUME GALLONS	3 MODE OF INLET	4 MODE OF OUTLET	5 SKIMMING ARRANGEMENT	6 SLUDGE COLLECTING MECHANISM	7 AVERAGE FLOW M.G.D.	8 MAX. RATE OF FLOW M.G.D.	9 MINIMUM DISPLACEMENT TIME IN HOURS	10 MAX. DISPLACEMENT TIME IN HOURS	11 AVERAGE RATE OF FLOW GALLONS PER SQ. FOOT PER DAY	12 HOW OFTEN IS SLUDGE PUMPED	13 APPROX. TIME AT EACH PUMPING	14 SETTLEABLE SOLIDS REMOVAL C.C. PER LITRE	15 SUSPENDED SOLIDS REMOVAL P.P.M.	16 SLUDGE RISING TROUBLE	17 DOES TANK HANDLE DIGESTED SUPERNATANT	18 SEWAGE TEMPERATURE CENT.	19 INDUSTRIAL WASTE SITUATION	MISCELLANEOUS NOTES
SAN MATEO	55' DIA. DEPTH 9.65' TO 11.94'	185,000	CENTRAL 4' BELOW SURFACE	PERIPHERAL WEIR 173'	ROTATING ARM BALL VALVE IN FRONT OF BAFFLE. EVERY 24 HOUR DISCHARGE	DORR	1.85	4.67	0.95	8.6	780	7 TIMES DAILY	15 MIN.	5.0 TO 0.30		TROUBLE IF TOO MUCH SLUDGE IS LEFT IN TANK	No. IT CAUSED EXCESSIVE SLUDGE RISING	12° TO 17°	NONE	
LAGUNA BEACH	14'X88'X8' RECT.	28,000	AT END UNDER BAFFLE 18" UNDER WATER	BAFFLED OUTLET AT END	TRAVELING AIR JETS BLOW SKIMMINGS TO TIPPING TROUGH	TRAVELING STRAIGHT LINE SCRAPER	0.15	0.38	1.75	13.5	325			8.5 TO 0.25		YES	No. TANK WILL NOT HANDLE IT	20° TO 25°	NONE	UNSATISFACTORY SLUDGE PUMP. DIFFICULTY IN OBSERVING SLUDGE BEING PUMPED PREVENT SATISFACTORY SLUDGE REMOVAL
DENVER (COLO.)	4 UNITS 140' DIA. S.W.D. 9'	1,030,000 EACH UNIT	CENTRAL (SIFEED)	PERIPHERAL WEIR 440'	MECHANICAL	DORR	11.0 EACH UNIT	13.25 EACH UNIT	1.88	2.26	716	HOURLY	VARIES		233 TO 45	NO	YES	7° TO 18°	SOME PACKING HOUSE WASTE	SLUDGE MOISTURE 94.8% B.O.D. REMOVAL 255 TO 123
SANTA CLARA	50' DIA. DEPTH 11' TO 13'	171,000	CENTRAL 3'-6" BELOW SURFACE	PERIPHERAL WEIR 157'	DORR ROTARY WITH TROUGH 6.5' LONG	DORR	0.665	2.02	2.04	12.75 BASIS OF LOW MONTHLY AVERAGE	1.174	GRAVITY TO 600 GAL. PIT 5 TIMES DAILY	3½ MIN. TO DRAW 600 GALS.	19.8 TO 0.74	433 TO 109	SERIOUSLY IN CANNING SEASON OCCASIONALLY AT OTHER TIMES	No. IT WAS DIVERTED TO EFFLUENT TO REDUCE SLUDGE RISING	20° TO 25°	CANNERIES. NORMAL SLUDGE OF 3000 GALS. IS INCREASED TO 5000 TO 7000 GALLONS	SEWAGE PUMPED IN INTERMITTENTLY AT RATE OF 1600 G.P.M. THIS FIGURE USED IN CALCULATION OF OVERFLOW RATE.
TERMINAL ISLAND LOS ANGELES	85' DIA. AVERAGE DEPTH 13'-5"	640,000	CENTRAL BAFFLED	PERIPHERAL WEIR 279'	ROTARY MECHANICAL AUTOMATIC TROUGH 10' LONG	ROTARY SCRAPER	3.0	4.0	3.8	7.0	528	EVERY 5 MINUTES	1½ MIN.	10.1 TO 0.7	400 TO 144	RARELY VERY SLIGHT	YES	20° TO 26°	LARGE FISH CANNERIES CAUSE MUCH TROUBLE WITH FLOATING GREASY WASTE. ESPECIALY OCT. 15 TO APRIL 1	SLUDGE PUMPS TIMED FROM CLARIFIER MECHANISM. SEWAGE PUMPED INTERMITTENTLY
YAKIMA (WASH.)	4 UNITS 90' DIA. S.W.D. 8'	377,000 EACH UNIT	CENTRAL (SIFEED)	PERIPHERAL WEIR 283'	MECHANICAL	DORR	3.6 EACH UNIT	4.5 EACH UNIT	2.0	2.5	570	HOURLY 8 A.M. TO 9 P.M.	5 MIN.		85 TO 38	NO	YES	7° TO 21°	HEAVY CANNERY LOAD	SLUDGE MOISTURE 92.8% B.O.D. REMOVAL: 96 TO 34
STOCKTON SOUTH	100' DIA. S.W.D. 15'	966,000	CENTRAL BAFFLED DORR	PERIPHERAL WEIR 314'	HYDRAULIC WASTEWAY ROTATING ARM	DORR	2.42	9.0	2.58	23	308	ONCE DAILY	1-2 HOURS	9.2 TO 0.01		AT TIMES	No	26° TO 29°	CANNERIES. DOMESTIC POPULATION 22 000. INDUSTRIAL POP. EQUIVALENT TO 108 000	SPECIAL SKIMMER BECAUSE OF HEAVY SCUM
STOCKTON NORTH	90' DIA. S.W.D. 15'	775,000	CENTRAL BAFFLED DORR	PERIPHERAL WEIR 283'	DORR FLOATING ARM + SIDE TROUGH	DORR	2.83	11.3	1.62	29	445	3 TIMES DAILY	2 HOURS	17.0 TO 0.01		No	No	19° TO 24°	CANNERIES. DOMESTIC POP. 30000. INDUSTRIAL POP. EQUIVALENT 185000	DYE EXPERIMENT AT FLOW OF 3.22 M.G.D. SHOWED DYE OVER WEIR FROM 27 MIN. TO 59 MIN. CALCULATED DETENTION TIME 5.8 HOURS.

RESOLUTION OF THE CALIFORNIA SEWAGE WORKS ASSOCIATION

By Authorization of the Membership

WHEREAS: It is a proper function of the California State Department of Public Health to foster and encourage better sanitary practice in the operation of Sewage Treatment Plants in the State of California and, furthermore, to improve the standards of operating personnel of such plants to the end that the public health be better protected and to the end that expenditures for these purposes be most efficiently made, and

WHEREAS: These purposes and functions can best be affected by tests of operation performed at the plants themselves, and by training and instruction taken directly to the operators, and

WHEREAS: The California State Department of Public Health has under its jurisdiction a Bureau of Sanitary Engineering whose proper function includes the foregoing; now, therefore,

Be It Resolved: By the California Sewage Works Association in convention assembled at Avalon, California, May 20, 1940, that the California State Department of Public Health is hereby petitioned and urged to:

FIRST, provide, maintain, and operate a traveling Sanitary Laboratory which shall be used in the examination and analysis of Sewage Treatment operations, in California; compare results among similar plants; and furnish results of such examination and analyses to the operators of plants through the state for the purpose of improving operation, and

SECOND, furnish from its staff trained, experienced, and competent personnel which will instruct operators of sewage treatment plants in the principles underlying sewage treatment and in operating technique, either on the initiative of the State Department of Public Health, or in collaboration with the Committee on Schools for Sewage Treatment plant Operators of the California Sewage Works Association.

The foregoing resolution was prepared by the Board of Directors pursuant to unanimous authorization of the membership of the Association present at the aforesaid meeting.

H. G. SMITH, *President.*
WM. T. INGRAM, *Secretary.*

RESOLUTION OF THE CALIFORNIA SEWAGE WORKS ASSOCIATION

By Authorization of the Membership

WHEREAS, It becomes increasingly apparent that these United States of America must prepare in every way for the defense of our country, and,

WHEREAS, It is important to the health of the civilian population, and,

WHEREAS, It seems vital to the successful and efficient operation of the various "key" industries of these United States that pumping stations, sewage disposal plants, laboratories, main outfalls, and storm drains be maintained in full operating condition at all times, now, therefore,

Be It Resolved: By the California Sewage Works Association in convention assembled, at San Diego, California, September 17, 1940, that the National Advisory Defense Commission and The California State Council of Defense are hereby petitioned and urged to prepare and give consideration to a planned program to cover the following items:

1. Prepare and study plans of pumping stations, disposal plants, main outfalls, and storm drains to the end that if and when breaks, accidents, or serious interference with normal operation occurs, sewage flow can be diverted or by-passed without serious contamination to water supply or create a condition which would be hazardous, dangerous, and ill advised to the public health, welfare and comfort of the civilian population.

2. Maintain supplies, materials, and provide for the necessary personnel to conduct emergency repairs to any structure, pipe line, pumping station, or appurtenances necessary to successful operation.

3. Provide the necessary equipment and arrange for the provision of personnel to provide for sterilization of sewage and of contaminated water during any emergency.

4. Arrange alternate methods of communication in the event that normal methods of service are interrupted.

5. Prepare suitable plans and arrange for the necessary personnel to make pumping stations, disposal plants, outfalls, storm drains, and any appurtenant structures necessary and vital to operation as inconspicuous as possible, when and if the necessity arises.

The foregoing resolution was prepared by the Board of Directors pursuant to unanimous authorization of the membership of the Association in convention assembled at the Hotel U. S. Grant, San Diego, California, on the seventeenth day of September, 1940.

H. F. GRAY, *President.*

WILLIAM T. INGRAM, *Secretary-Treasurer.*

RESOLUTION OF THE CALIFORNIA SEWAGE WORKS ASSOCIATION

By Authorization of the Membership

WHEREAS: Cross connections between water supplies and sewage lines are known to exist at most sewage treatment plants and pumping plants, and

WHEREAS: Such cross connections are a menace to the safety of the water supply, through possible back-flow and back-syphonage, and

WHEREAS: There is need for the operators to discover and correct all possible cross connections, including cooling lines to compressors and gas engines, pump priming and water seal lines, submerged inlets, including hoses, water-operated skimming nozzles, chlorinator water feed lines, lines to venturi cleanouts and float wells, and back wash lines to sludge and sand filters: now therefore

Be It Resolved: By the California Sewage Works Association in convention assembled at San Diego, California, September 17, 1940, that operators of sewage plants, pumping stations, and similar structures be urged to study the problem of cross connections existing in such works, and take such steps as are necessary to protect the water supplies by a break in connection, vacuum breakers, and/or valves designed to prevent back-flow and back-syphonage.

The foregoing resolution was prepared by the Board of Directors persuant to unanimous authorization of the membership of the Association in convention assembled at the Hotel U. S. Grant, San Diego, California, on the seventeenth day of September, 1940.

H. F. GRAY, *President.*

WILLIAM T. INGRAM, *Secretary-Treasurer.*

In Memoriam

This Association has had the misfortune this past year to lose three members who were known nationally as well as locally.

A. K. WARREN passed away August 28, 1940, after a relatively brief illness. Mr. Warren was born in Staughton, Wisconsin in 1887. His early engineering experience was gained with Northwestern railroads. For 10 years, beginning in 1914, Mr. Warren was in the employ of the Los Angeles County Surveyor.

Through his activity and perseverance and in cooperation with many men, the County Sanitation District Act became Law in 1923. In 1924 the Districts of which he became Chief Engineer and General Manager were formed. Mr. Warren was a charter member of the California Sewage Works Association, and was one of the staunch supporters of the organization.

ALEXANDER BELL passed away on December 10, 1940, after nearly a year of ill health. Mr. Bell was born in Milwaukee, Wisconsin, in 1882. His first connection with the Wallace and Tiernan Company was in 1919. We, on the West Coast, know what he accomplished as the Western Manager of this company. "Alex," as he was known to everyone, was another advocate of the California Sewage Works Association. He, as a charter member, did much to assist the organization, and throughout his life gave time and energy to the encouragement of good sewage works operation. The Award of Merit Plaque offered each year by Wallace & Tiernan, is evidence of this. Alex was president of the California Sewage Works Association in 1939. His genial countenance and intelligent attitude will be remembered for many years.

GEORGE B. GASCOIGNE died suddenly August 17, 1940. He was born at Oak Harbor, Ohio in 1884. He was known to us by national reputation as a capable engineer. He opened an office in Cleveland, Ohio in 1922, and another in New York in 1936. Mr. Gascoigne had maintained membership in the California Sewage Works Association since 1931.

OHIO RIVER POLLUTION SURVEY—THE FIRST YEAR'S WORK

By **H. R. CROHURST and E. S. TISDALE**

Senior Sanitary Engineer & Sanitary Engineer (R)

U. S. Public Health Service, Office of Stream Sanitation
Ohio River Survey, Cincinnati, Ohio

The Ohio River Pollution Survey is one of the largest, if not the largest, attempt to evaluate the pollution problem on a major watershed and to make recommendations, together with cost estimates, of the remedial measures deemed necessary to maintain or restore the various watercourses to a condition which their greatest use would appear to justify. This survey has demonstrated the practicability of utilizing existing resources of federal and state agencies, and of cooperating with municipalities and industry, to obtain the various classes of information which are essential to ascertain the present sanitary condition of our streams and outline a practical remedial program.

Cooperating on the Ohio River Survey are the Corps of Engineers of the U. S. War Department, the U. S. Public Health Service now of the Federal Security Agency, the Bureau of Fisheries, Department of Interior, the U. S. Geological Survey, Department of Agriculture and the Tennessee Valley Authority, all of which are departments of the federal government; the health organizations of the fourteen states, portions of which States lie in the Ohio River drainage basin and several of the state conservation agencies; a number of the larger municipalities, in which problems of sewage disposal are becoming acute and in which special studies of sewage collection and treatment are in progress, and all of the municipalities and industrial establishments which in the end necessarily must supply a large part of the information pertaining to water uses and the kinds, amounts and effects of pollution.

The authorization of the Ohio River Survey by the Congress appears to be the beginning of a second phase of the broad public health cycle concerning the inter-relationships between public water supply, sewage and industrial waste disposal and stream sanitation.

The earlier phase of this broad field of sanitation dealt with the application of the principles of water filtration to public water supplies in large and small cities throughout the country. Between 1900 and 1930 came the practical application of these sanitation principles in large American cities where the public generally were convinced that money could be spent profitably to insure safe drinking water supplies and banish water-borne typhoid fever.

Increasing pollution in many of our streams used as sources of public water supply, is placing a constantly increasing burden on existing water treatment devices, and in order to maintain the low rates of water-borne diseases established through efficient water treatment processes, the treatment of sewage and other wastes will become increasingly necessary to reduce the raw water pollution load to the point where it can continue to be handled by present known methods of water purification.

This second phase of waste disposal in relation to stream sanitation is just beginning and is based upon the principles in the field of water treatment, sewage and industrial waste disposal and stream pollution control worked out

to a large extent through research at the Stream Pollution Investigations Station of the Public Health Service at Cincinnati, Ohio, during the past 25 or more years.

Other forces have appeared within the past several years to speed up the effort to cleanse our streams and reclaim from pollution a most valuable national resource—water. These important forces, among others, include:

(A) Increasing recreational demands on the part of the general public, together with more dependable transportation facilities emphasize the need for cleaner streams for fishing, swimming and camping, not only close to metropolitan centers but in ever widening zones from points of major pollution concentration.

(B) The report of the Special Advisory Committee on Water Pollution of the National Resources Planning Board, together with the recommendations of the President to the Congress outlining desirable federal stream pollution control legislation, has done much to stimulate pollution abatement efforts.

(C) The federal public works and relief programs, making considerable sums of money available for the construction of sewage treatment plants through the cooperative effort of the P.W.A. and W.P.A., federal and state agencies, have demonstrated that the pollution of streams can be controlled. Effective control calls for the expenditure of funds and the exercise of judgment and experience in planning remedial measures in drainage basins of which the pollution abatement problem is only one of several conservation problems.

These forces, together with other developments, have been instrumental in formulating the Ohio River Pollution Survey which is authorized in Section No. 5 of the River and Harbor Act approved August 26, 1937 in the following language:

> "that the Secretary of War is hereby authorized and directed to cause a survey to be made of the Ohio River and its tributaries to ascertain what pollutive substances are being deposited directly or indirectly therein and the sources and extent of such deposits and with a view to determining the most feasible method of correcting and eliminating the pollution of these streams."

The authorization also provided for the War Department to secure the assistance and cooperation of the U. S. Public Health Service in carrying out the fact finding and control investigations. In addition to the cooperation among federal and state agencies, municipalities and industry, the President recommended, in approving the River and Harbor Act, that the survey be made under the general supervision of a committee of three, now known as the Ohio River Committee. This committee consists of a representative of the Corps of Engineers, a representative of the U. S. Public Health Service, and a third member chosen by the other two, a non-governmental expert in water supply and sewage disposal. The field headquarters of the survey are located at Cincinnati, near the center of the watershed, in which are situated the Stream Pollution Investigations Station and the Office of Stream Sanitation of the U. S. Public Health Service and the Division Engineer's office, Corps of Engineers, Ohio River Division.

Ohio River Basin

Comprising some 204,000 square miles of watershed lying in parts of

fourteen states, on which approximately nineteen million persons reside on twenty-two major tributary basins, the Ohio River system is of necessity used extensively as a source of water supply and as a means of sewage and waste disposal.

Over five million people obtain their domestic water supply from the streams of the basin and approximately the same number use it as a means of sewage disposal. A large percentage of the domestic wastes are being discharged into the Ohio and its tributaries without treatment.

Industry throughout the Ohio River basin is exceedingly diversified with coal, steel, petroleum and agriculture dominating. To the untreated sewage are added large amounts of industrial wastes from the numerous manufacturing establishments throughout the watershed. Enormous amounts of acid mine drainage from active and abandoned mines in the extensive bituminous coal fields in several sections of the watershed also find their way to the watercourses.

Recreational use of a considerable part of the waterways has been destroyed by the excessive discharge of sewage and other wastes into them. The question of public health now appears to be involved, as evidenced by the outbreaks of intestinal disturbances reported from time to time along the river and some of its tributaries. Following long periods of drouth, public water supplies seem to be detrimentally affected as the pools behind the navigation dams, some 53 in number, are flushed out when stream flows increase.

Complicating any program of pollution abatement on the watershed are the navigation structures on the main stream and on a number of the larger tributaries. The proposed flood control program of the Corps of Engineers involving construction of numerous reservoirs on tributaries also will modify present stream flow conditions.

Division of the Work

The Ohio River Committee recommended concentration of the survey work on the middle third of the watershed during the first year of the study, 1939. This includes an area which extends from just above the mouth of the Kanawha River near Point Pleasant, West Virginia, to just below the mouth of the Kentucky River near Carrollton, Kentucky, a river distance of about 280 miles, and a watershed area of about 50,000 square miles. The work divided itself logically into three main divisions.

(1) The hydrometric studies, undertaken by the Corps of Engineers, U. S. Army, were under the immediate supervision of the Division Engineer at Cincinnati, assisted by the district offices of the Corps at Huntington and Cincinnati working with the U. S. Geological Survey and other agencies making hydrometric studies. Records of flow were obtained on most of the watercourses, to indicate conditions at the time of sampling, for the purpose of calculating times of flow and comparing conditions during sampling with minimum periods of runoff.

(2) The laboratory studies for the analysis of water samples collected from the streams were logically assigned to the Stream Pollution Investigations Station of the U. S. Public Health Service at Cincinnati where research studies on water purification, sewage treatment and stream purification phenomena have been in progress for over 25 years. Laboratory facilities during the first year were available at the Stream Pollution Station, Cincinnati, and

on a quarterboat made available by the U. S. Engineer Dept. which was transformed by the Public Health Service into a modern floating laboratory. In testing water from the upper portions of tributaries, mobile auto-trailer laboratories were designed and equipped for field use. A minimum of laboratory determinations was made to estimate the sanitary quality of the streams and the extent of the remedial measures required. Including attendants, helpers and office personnel, 31 persons were connected with the laboratory studies during 1939.

(3) The securing of accurate information on the amount, types, locations and effects of pollution was assigned to the Office of Stream Sanitation, Cincinnati, Ohio. The field surveys have endeavored to ascertain the extent and efficiency of sewage treatment works and waste disposal practices, together with the quality and treatment of public water supplies. The most important water uses in the basin were ascertained.

Following the twenty or thirty-year old policy of cooperation with state health departments which has been so effective in advancing the public health of the nation in the field of safe water and milk, proper sewage disposal, malaria control and public health administration generally, trained public health engineers were detailed to the state health agencies of Ohio, West Virginia, Kentucky and Tennessee and to the Tennessee Valley Authority. Thus, with a minimum expenditure of effort, time and money, it was possible to collect existing information on water supply, sewage disposal and industrial waste treatment on file with these agencies. Extensive field investigations were made during the first year to supplement the existing pollution data on this 50,000 square mile area. In all, including office personnel, 20 persons were engaged in the above surveys of "sources of pollution" data.

ACCOMPLISHMENTS IN 1939

General

There were completed, during the first year, studies of eight of the twenty-two major drainage basins, three north of the Ohio River; the Miami, Little Miami and Scioto River watersheds and five south of the main river; the Kentucky, Licking, Big Sandy, Guyandot, and Kanawha River watersheds.

Economy of time and money has resulted from placing field engineers at State Health Department headquarters and with the Tennessee Valley Authority. The accumulated experience, good will and intimate knowledge on the part of State Health Department personnel gained over a period of 20 to 30 years has been a potent factor in securing accurate and reliable data during the first year.

Engineers at field stations have quickly obtained estimates of amounts of sewage and industrial wastes at each community and the effect of this pollution, whether treated or untreated, on the receiving stream and at points downstream. Sewage and industrial waste loadings after evaluation have been shown graphically. Major uses of water on each basin have been ascertained. The necessary remedial works have been determined and the costs of the remedial program ascertained. In addition to completion of the middle third of the watershed, a substantial amount of work has been done in the Tennessee and Cumberland Basins.

Public Water Supplies and Sewage Disposal Practice

There were 3876 sewage treatment and water supply investigations carried out by the field engineers the first year, divided equally between water and sewage studies. In connection with the information collected the following points are of interest.

It was found that in many sections of Ohio, West Virginia, Kentucky, Tennessee and Indiana sewage treatment plants are now deemed an essential unit of the structure of a modern city. The cities are accepting the obligation to treat their dirty wastes before discharging them into the nearby stream. The Special Advisory Committee's report made at the request of the President emphasized this trend in America and indicated an increase in urban sewage treatment in the United States from 31% to 54% between 1932 and 1938 due to the financial stimulus of P.W.A. and W.P.A. The trend in the middle third of the Ohio Basin toward sewage treatment was definite and outstanding in the three drainage basins north of the Ohio River, the Scioto, Miami and Little Miami, where 50 cities provided safe and adequate waste disposal facilities for approximately 850,000 people during the past six years.

Industrial Investigations

Approximately 550 large industrial plants in the eight drainage basins and on the main Ohio River have been investigated with excellent cooperation on the part of industry. These include distilleries, pulp and paper mills, corn, tomato and pea canneries, packing and slaughter houses, tanneries, petroleum, milk, chemical and acid pickle liquor plants. Population equivalents of the wastes from plants have been estimated so that on each drainage basin, the total population equivalent of the wastes has been ascertained.

In addition to field and office investigations of industrial waste loading, it was considered worth while to prepare industrial waste guides in which up-to-date, available information on volume, strength, and sewered population equivalent of wastes and successful remedial measures has been summarized under ten classifications: namely, (1) brewery, (2) tannery, (3) paper, (4) paper pulp, (5) corn cannery, (6) tomato cannery, (7) meat, (8) milk, (9) oil and (10) by-product coke.

Thus the Ohio River Pollution Survey has endeavored to collect and correlate industrial waste data and successful methods of treatment for typical wastes in the Ohio Basin, making this pertinent information available to other workers in the stream pollution field.

Laboratory Operations and Work Accomplished During 1939

Two well equipped laboratories, one on land located at the Stream Pollution Investigations Station of the Public Health Service at Cincinnati, Ohio, and the other a floating laboratory stationed at Ashland, Kentucky, established in the Engineer Corps Quarterboat "Kiski," have served as convenient foci, to which samples were brought on a daily schedule by motor boats and automobiles, operated to collect water samples from the main Ohio River and the lower ends of tributary streams.

Two auto-trailer unit laboratories, increased this year to six in number, provided the necessary flexibility to reach out into the upper portions of these eight tributary watersheds in Ohio, Indiana, West Virginia and Kentucky for analytical studies.

Up to March 31, 1940, 28,440 samples of water had been collected, upon which 35,555 physical and chemical determinations, 17,161 bacteriological tests and 911 biological enumerations had been made. The minimum number of analytical tests, consistent with showing the degree of pollution in the stream have been made. As a routine practice, the following determinations in whole or in part, as appears necessary, are made on the samples collected:

Temperature	pH (Hydrogen-ion Conc.)
Dissolved Oxygen	Nitrites
Five-day biochemical	Turbidity
Oxygen Demand, 20° C	Alkalinity
Bacteria on agar	Suspended Solids
24-hour count at 37° C	Total
Coliform organisms	Volatile
M.P.N. (by dilution meth.)	Hardness
Direct count	

Nitrites are determined frequently to check the necessity for using the azide modification in determining dissolved oxygen by the Winkler method. Soap hardness is made on typical stream samples.

Using independent methods of ascertaining pollution by means of the biological tests, it appears to have been demonstrated that a close correlation exists between the results obtained from biological findings and those derived from chemical and the bacteriological data.

The laboratory classifications taken in conjunction with the loads of pollution and the critical stream flows, determined from the hydrometric data gathered by the Corps of Engineers, have furnished the fundamental data from which conclusions will be drawn and recommendations made as to the necessary remedial measures and their cost.

Epidemiological Studies

The Ohio River Committee authorized a special study in connection with the Ohio River Survey, which has been under the supervision of an experienced epidemiologist who has investigated from the clinical, engineering and epidemiological viewpoints the question of the alleged prevalence of intestinal disorders, diarrhea and enteritis, in cities along the Ohio River, particularly following low water conditions.

Several outbreaks of intestinal trouble in different parts of the Ohio Basin have been studied during 1939 and a statistical study of death rates from diarrhea-enteritis in the registration cities over 10,000 in the Ohio Basin has been completed.

Plans for 1940-41 to Complete the Work in Ohio Basin

The staff of field engineers and laboratory workers, the equipment, boats, trailer laboratories, are all being expanded in 1940 in an endeavor to more rapidly gather the information on pollution and complete, as soon as possible, the field studies in the 22 large watersheds which made up the entire Basin.

Additional cooperative studies are being undertaken with the States of Pennsylvania, Indiana and Illinois by placing field engineers with these agencies to assemble existing information and make the necessary field surveys in these remaining states.

A motor boat will operate along the lower Ohio River, downstream from

Carrollton, Kentucky in conjunction with a trailer laboratory stationed on shore to cover this portion of the Ohio. The floating laboratory "Kiski" will cover the main river upstream from Pt. Pleasant to Pittsburgh, supplemented by a field laboratory at or near Greensburg, Pennsylvania. Trailer units, four in number, will operate in northeastern Ohio, northern West Virginia, western Pennsylvania and in southwestern Kentucky.

The biological studies will be expanded and a mobile field unit is being provided so that the effects of pollution upon fish life may be studied.

The Bureau of Fisheries will cooperate more fully in the biological studies and as a result of a recent meeting at Cincinnati between field staffs of the Bureau of Fisheries and the U. S. Public Health Service, a definite plan has been agreed upon whereby fish populations and species in selected typical areas, some clean, some partially polluted and some heavily polluted streams, will be determined. In this study, the laboratory of the U. S. Bureau of Fisheries at Columbia, Missouri, will assist materially.

It cannot be emphasized too strongly that the aim of this survey is *not research,* but the practical application of known principles of stream sanitation in an extensive stream pollution abatement program. The work was authorized by Congress in order that a practical engineering plan of stream sanitation might be clearly outlined for the entire Ohio River Basin.

For each subdrainage river basin as well as the main Ohio, an attempt will be made to show in the final report the total pollution load due to the wastes discharged into it, the sanitary condition of the stream at the present time, the necessary sewage and industrial waste treatment plants recommended, together with their costs, to bring about the changes which the chief water uses in the particular portion of the stream would appear to warrant, and finally to present an outline of the administrative procedures available to bring about the pollution abatement program deemed necessary.

An endeavor is being made to complete the field work of the survey early in 1941 and prepare the final report as soon thereafter as possible.

DEVELOPMENTS IN CANNERY WASTE STUDIES AT PALO ALTO

By **JACK H. KIMBALL,**
Assistant Superintendent Water and Sewer Division
and **HAROLD L. MAY,**
Chief Operator Sewage Treatment Plant

The studies on cannery wastes which have been undertaken at Palo Alto have been of a general nature only, as it has not been possible for the writers to spend their full time and energy on this work due to other departmental duties. However, the results obtained so far do reflect a picture of the problem which must be solved in the near future if satisfactory treatment is to be obtained.

The problem is created by the mixing of cannery wastes at the rate of approximately one million gallons per day to domestic sewage at a point one hour's distance from the Treatment Plant. The ratio of the volume of cannery waste to the volume of domestic sewage is 2 to 1 during low

domestic flows, and 1 to 2 during peak domestic flows. By the time the mixture enters the clarifier the pH has dropped to 6.0 and gas is forming to such an extent that practically all sludge rises immediately to the top. Most of this floating sludge is carried over the effluent weir and out to San Francisco Bay.

The problem which faces the Alto Plant is to determine the most practical and economical method by which an effluent can be produced during the four month canning season which is comparable to the effluent produced during tht rest of the year.

Studies Undertaken

Effect of Cannery Waste on Quantity of Sewage Received at Treatment Plant: Figure 1 shows the average daily flow for seven day intervals for the six year period, 1934-1940. Weekly averages were used in order to dampen out extreme variations. The volume of water contributed by the cannery during each season can be compared with the normal dry weather flow of 1.4 M.G.D. just after Stanford University has closed (latter part of June) and just prior to the apricot season.

A considerable reduction in the amount of water used by the cannery may be noted for the years 1937, '38 and '39 as compared with the years 1935 and '36, even though the amount of material handled by the cannery has steadily increased. This reduction was accomplished by re-circulating reclaimed water through the floor drains rather than using fresh water. The volume of water used during the 1940 peach season has increased due to a proportional increase in the tons of fruit packed. The volume of water used per ton of raw fruit has been determined for the 1940 season as shown in Table 1.

***Table 1*—STRENGTH OF CANNERY WASTES**

1940 Season Compared with 1936 Season

	Season	*Spinach*	*Apricots*	*Peaches-Pears*	*Tomatoes*
Maximum Pack—Raw Fruit	1940	85	180	357 111	675
Tons per Day . . .	1936	71	120	208 41	196
Cases per Ton	1940	46	58	45 38	38
of Raw Fruit	1936	----	----	---- ----	----
Volume of Waste Water	1940	7,400	4,700	2,900	2,000
Gallons per Ton . . .	1936	8,100	2,500	5,180	3,600
B. O. D. in p.p.m.	1940	615	1,020	1,340	----*
Five Days	1936	730	380	1,350	990
Population Equivalent	1940	230	250	200	100
Persons per Ton . . .	1936	290	49	179	180
Population Equivalent					
For Maximum Pack	1940	20,000	45,000	93,000	67,500
Total Persons	1936	20,800	5,900	37,300	35,300

*1936 B.O.D. used in computing population equivalent.

Effect of Cannery Waste on Strength of Sewage Received at Treatment Plant. Figure 2 shows the B.O.D. values of 24 hr. composite samples of raw and settled sewage for the six year period 1934-1940. An average weighted curve for this six year period was drawn to show the relative strength of the domestic sewage with and without cannery waste. The only value of this curve is that it emphasizes the fact that wastes from the cannery nullify the effectiveness of the Treatment Plant for at least four months out of every year, thus defeating the original purpose of the plant.

Chlorine Requirements of Domestic Sewage with Cannery Waste. In 1938 a series of tests were run at the suggestion of Mr. Carl Beyer, District Manager, Wallace and Tiernan Sales Corporation, to obtain information on the hourly variation in strength of domestic sewage and sewage with different cannery wastes, as measured by its chlorine demand. Figure 3 shows the variation in H_2S, Rate of Flow, and Chlorine Demand of domestic sewage between the hours of 6:00 A. M .and 10:00 P. M. A residual of 0.3 p.p.m. of chlorine after a five minute contact period was arbitrarily used for comparison of chlorine demand. The curves show that when the sewage flow was at its peak, 12 o'clock noon, the strength of the sewage was also at a maximum. In order to show the total load received at the plant during each hourly period of the day, the rate of flow was combined with the corresponding chlorine demand and the results expressed in rate of chlorine application, lbs. per 24 hrs., that would be required to satisfy the total demand. These values are represented by the lower curve on Figure 3, and indicate that a maximum rate of 600 lbs. per 24 hrs. was required for domestic sewage.

Figure 4 shows a similar series of tests on domestic sewage containing peach canning wastes. A maximum rate of 900 lbs. per 24 hrs. was required under the existing conditions. During the 1940 season, however, the cannery packed peaches at their maximum capacity which was three times greater than the quantity packed in 1938 when the tests were run. The chlorine demand for days of maximum pack will consequently be higher than shown by Figure 4, and will extend over a longer period of time,—about sixteen hours.

Similarly, Figure 5 shows a series of tests on domestic sewage containing tomato wastes. The maximum rate of chlorine application required was about the same as for domestic sewage alone, 600 lbs. per 24 hrs., but continued over a longer period of time. These values, as for peaches, do not represent maximum conditions at the present time. During the 1940 season seven times as many tomatoes were packed in one day as on the days when these tests were run.

Pears are also packed by the cannery in considerable quantities, but only at times when peaches or tomatoes are also being worked, and consequently, isolated tests on domestic sewage containing pear wastes could not be obtained.

Figures 4 and 5 indicate that a considerable load is placed on the Treatment Plant when only one product is being packed. Depending upon the season, however, there is a period of two weeks or so when Peaches, Pears and Tomatoes are being packed at the same time. It is during this period that the quantity and strength of the cannery waste is liable to be at a maximum, and plans for future treatment should be based on these conditions.

Strength and Quantity of Cannery Waste. Tests have also been run on

the straight cannery waste from time to time in order to determine its strength in terms of Biochemical Oxygen Demand. Although the number of tests have been limited, the results obtained have made it possible to determine roughly the population equivalent of each waste. The quantity of fruit packed and the volume of water used for each day's run has been obtained from the Superintendent's Office for each year since 1936. With this information on hand, tests run at the Treatment Plant can be correlated with the quantity of cannery waste received for any particular day.

During the last several years the cannery has been improved to a considerable extent. Table 1 has been made up to show the tremendous increase in the maximum daily capacity as compared with 1936, when the fruit studies were made on the cannery wastes. The amount of waste reaching the Treatment Plant on a maximum day is indicated by the total population equivalent. The waste from peaches and pears on a day of maximum pack is equivalent to the waste from 93,000 people. The number of such days fortunately does not occur very often during any one season. The average day's pack is usually from 50 to 75% of the maximum capacity of the cannery.

As the plant now serves a total population of 23,000 people, and was designed for only 27,000 people, one cannot expect a satisfactory effluent when wastes equivalent to 50,000 or so people are added to the domestic sewage.

Removal of Small Solids with a Finer Screen

During the Sewage Plant Operators Regional Conference at Santa Clara on June 27, 1940, as arranged by Mr. G. E. Arnold, Chairman of the Committee on Schools and Certification, the subject of fine screens for cannery waste treatment was discussed along with other subjects. As a direct result of this discussion a recommendation was made to the cannery that they install a second screen which would remove as much of the solids as practicable, but small enough to catch tomato skins.

Up to this time all wastes were run through a ½″x1″ screen which removed the bulk of the material. Sliced peaches, apricot pits, pear cores, tomato skins, etc., however, would slip by and end up floating on top of the clarifier at the Treatment Plant. The fine screen which was installed by the cannery was quite successful in removing the small solids, except for the tomato skins. Many of the skins would not wash down into the discharge buckets, but would ride over and be washed off by the screened sewage. The fine screen does, however, remove approximately 1 cubic yard for every 9 cubic yards removed by the coarse screen. Although this screen has improved conditions at the plant in regard to solid material, it is only the first step toward adequate treatment.

Information on the Coarse Screen. The coarse screen is 20″ wide with ½″x1″ openings and has buckets spaced every 9″. The screen, which is of the continuous type, is driven by a 2 horse-power motor at a linear speed of 0.68 ft. per second.

Information on the Fine Screen. The fine screen is 10″ wide, with openings approximately ⅛″ wide, and has buckets spaced every 1′ 5″. This screen is supported by a coarse screen similar to the above, and is driven by a 1¼ horse-power motor at a linear speed of 1.21 ft. per second.

Chemical Experiments on Sewage Containing Cannery Wastes

In an effort to find a means of preventing sludge from rising in the clarifier, the effects of ferric chloride, lime and chlorine were investigated.

All samples treated were catch samples of raw sewage as received at the Treatment Plant, taken near mid-day, when the sewage was judged to be the strongest. In all the tests performed, sludge volumes were recorded when possible. These volumes ranged from 34 to 163 ml./liter for 2 hr. settling period.

Most of the samples used as controls came to the surface immediately. 40 minutes was the longest time the sludge remained down in an untreated sample. The cannery was packing chiefly tomatoes and pears during this series of tests.

Ferric Chloride. Samples were dosed with ferric chloride from 20 to 300 p.p.m., equiv. CL_2 mixed for 30 seconds and flocculated for 30 minutes. Control samples were set up at the same time, receiving the same mechanical treatment of mixing and flocculation.

Samples containing ferric chloride, in general, were but slightly better than the controls. Mixing and flocculation had the effect of releasing the gases in the sewage, allowing the sludge to settle. However, gases soon formed again bringing the sludge to the surface.

One sample with a dose of 50 p.p.m., stayed down 2 hrs., with the control remaining down 50 minutes. Another sample with 70 p.p.m., remained down 2 hours and 15 minutes with 1 hr., 28 min. for the control.

It seems, therefore, to prevent the sludge from rising, the problem is to release the gases in the sewage as it is received and by some means retard the formation of these gases until the sludge can be settled and removed from the clarifier.

Effects of Lime. Samples were dosed with lime from 10 to 750 p.p.m., mixed for 30 seconds and flocculated for 30 minutes, together with controls.

Lime was not effective until the dose was large enough to bring the pH of the sample above 7.0. The minimum dose to effect this in the samples treated was 250 p.p.m., maximum 600 p.p.m. In all samples where the pH had been raised to 7.0, the sludge stayed down over 18 hours. The maximum time for the samples with a pH of 6.8 or below was 1 hr. and 25 min.

Lime plus mixing and flocculation would solve the problem, but the quantities of lime to effect this are considerable.

Effects of Chlorine. The chlorine demand of the samples were first determined and then dosed with quantities above and below the demand. The demand ranged from a minimum of 20 p.p.m. to a maximum of 70 p.p.m. In each case the sample plus chlorine was mixed moderately for 5 minutes.

In the minimum and maximum cases 15 p.p.m., and 60 p.p.m., kept the sludge down over 4 hours. Doses below that were but little more effective than the controls.

Chlorine also would solve the problem, but again, the quantities needed are considerable.

It was thought that, perhaps, the amount of chlorine might be cut down, if either the cannery waste or the domestic sewage were chlorinated before

becoming mixed. To this end catch samples of each were taken, and portioned and mixed in the laboratory as nearly as possible to simulate the conditions that exist in their mixing and flowing through the sewer down to the plant. To produce the same results it took approximately one-half as much chlorine to chlorinate the domestic before mixing with the cannery waste, than chlorinating the cannery waste alone, and approximately one-fourth the amount needed if chlorination was performed at the plant. However, several other factors make the chlorination of the domestic sewage before mixing with the cannery waste impractical.

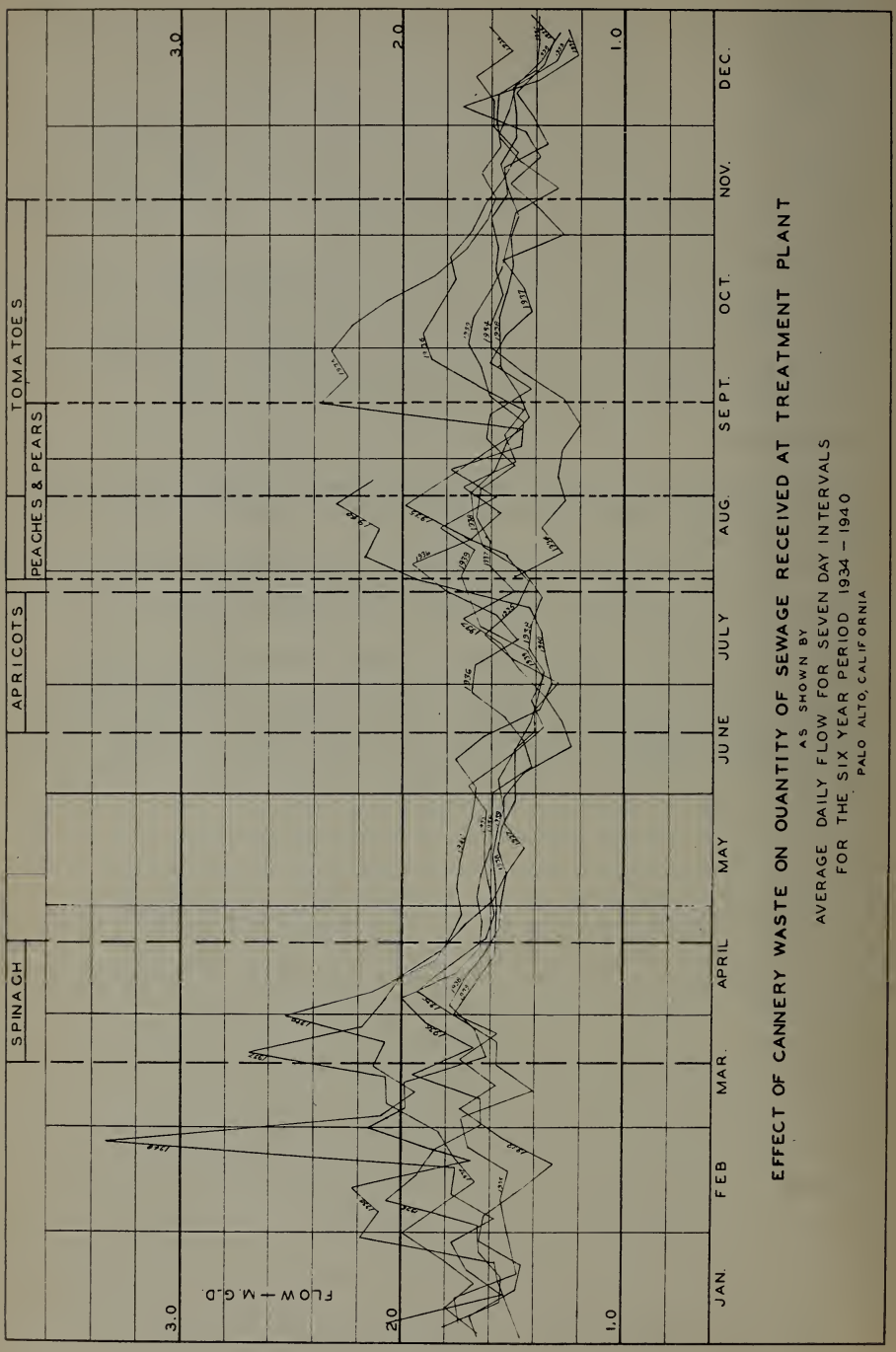
It seems, then, that chlorination of the cannery waste before entering the domestic sewers would, in our case, be the most logical point for chlorination. Chlorination at the cannery would make possible the purchase of chlorine in tank car lots, due to the spur track facilities. Accurate control of the rate of application would also be possible since variation in strength and quantity of the cannery waste would be readily apparent.

Conclusions:

Tests performed so far have not been extensive enough to arrive at any definite conclusions and more work must be done before actual recommendations can be made.

One definite part of the treatment that must be performed at the cannery, however, is the installation of a screen fine enough to prevent all tomato skins from entering the sewer.

It is felt that the studies so far have shown that some sort of treatment, such as chlorination of the cannery waste before it is discharged into the domestic sewer, is necessary before it will be possible to remove settleable solids, and that further treatment of some secondary nature is needed to produce an effluent which is comparable to that produced during the balance of the year.



EFFECT OF CANNERY WASTE ON QUANTITY OF SEWAGE RECEIVED AT TREATMENT PLANT

AS SHOWN BY

AVERAGE DAILY FLOW FOR SEVEN DAY INTERVALS

FOR THE SIX YEAR PERIOD 1934 – 1940

PALO ALTO, CALIFORNIA

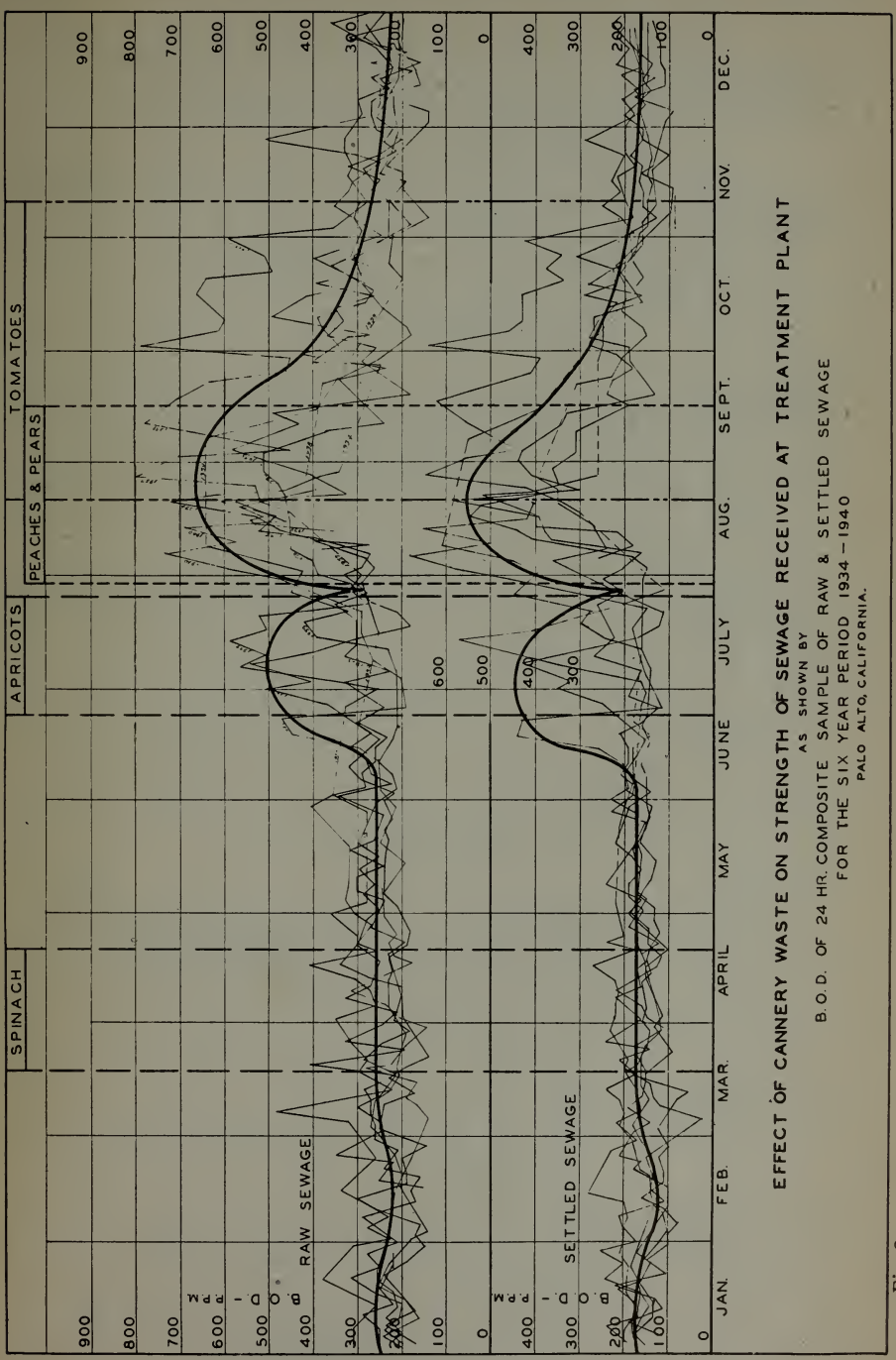
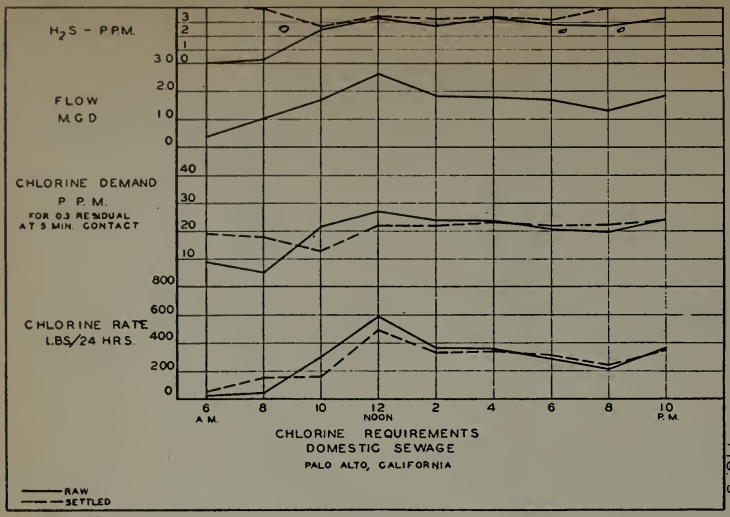
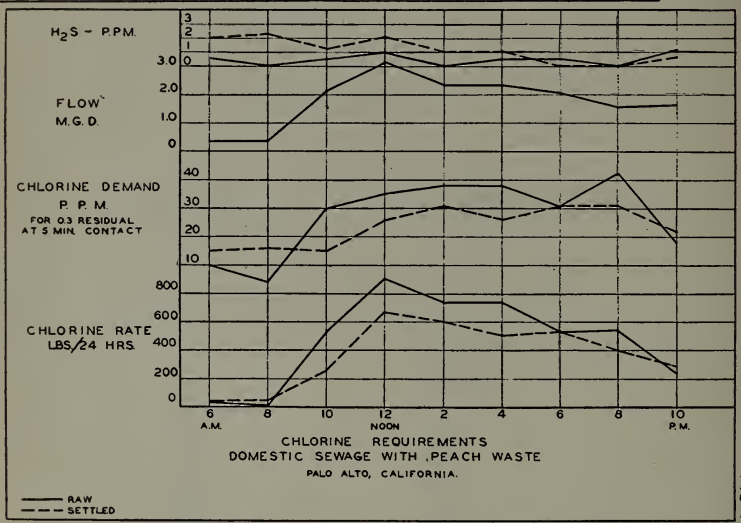

SPINACH
APRICOTS
PEACHES & PEARS
TOMATOES
900
800
700
600
500
400
300
200
100
0
P.P.M. O.D.
RAW SEWAGE
SETTLED SEWAGE
JAN.
FEB.
MAR.
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
EFFECT OF CANNERY WASTE ON STRENGTH OF SEWAGE RECEIVED AT TREATMENT PLANT
AS SHOWN BY
B.O.D. OF 24 HR. COMPOSITE SAMPLE OF RAW & SETTLED SEWAGE
FOR THE SIX YEAR PERIOD 1934 – 1940
PALO ALTO, CALIFORNIA.

Fig. 2



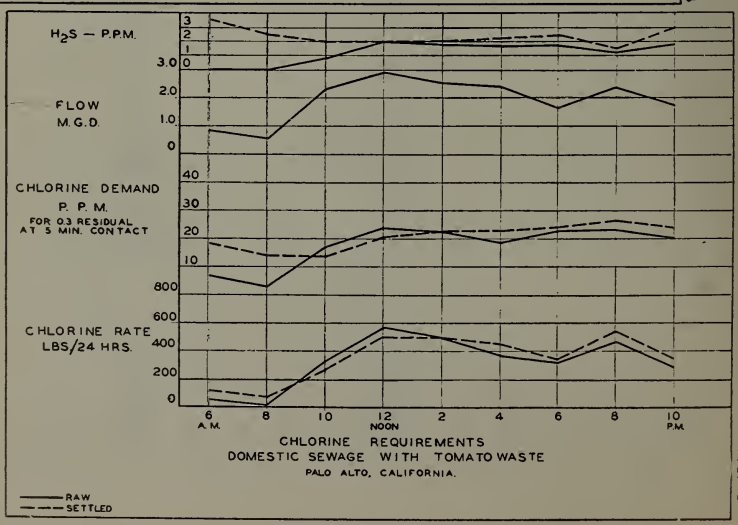
CHLORINE REQUIREMENTS
DOMESTIC SEWAGE
PALO ALTO, CALIFORNIA

FIG. 3



CHLORINE REQUIREMENTS
DOMESTIC SEWAGE WITH PEACH WASTE
PALO ALTO, CALIFORNIA.

FIG 4



CHLORINE REQUIREMENTS
DOMESTIC SEWAGE WITH TOMATO WASTE
PALO ALTO, CALIFORNIA.

FIG. 5

PROBLEMS OF INDUSTRIAL WASTES FROM THE STANDPOINT OF CITY ADMINISTRATION

By **W. T. KNOWLTON**

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1. *Importance of Subject:* The problems of industrial wastes from the standpoint of the City Administration commence when a city is formed. As the city increases in population, these problems will increase in importance. In a small residential city, it is doubtful if there are any industrial wastes to be encountered other than what comes from a laundry and the oil wastes from garages and service stations. When cleaning and dyeing plants are established, and other industries are started that desire to dispose of their waste water, the problem begins to attract the attention of the City Administration. Industrial plants that require some means of disposal for their wastes are willing that the City Administration shall look after such disposal.

In Vol. III of American Sewerage Practice by Metcalf and Eddy as revised in 1935, industrial waste is defined as waste waters carrying suspended, colloidal, and dissolved matters produced by manufacturing processes and discharged therefrom as being of no commercial value. As the usual custom is to have these waste waters from industrial plants, which are located in cities, discharged into the public sewers, the writer has prepared this paper with special reference to such disposal and the problems produced thereby.

In return for the city providing for the disposal of the industrial wastes, it has been suggested that the industries should bear some part, if not all, of the cost of preliminary treatment of such wastes, when the city finds that such treatment is necessary. Industries cannot in all cases solve the problem of disposal, but they should cooperate with the city in the matter. Each has a part in providing for the welfare of the community.

The problem of industrial waste disposal is very puzzling at times to the city official when he realizes that on one hand the industry is a large corporation paying a generous share of the taxes, while on the other hand this industry is creating a serious condition or nuisance that is affecting the health of the community, and demands relief.

The technical problems pertaining to industrial waste disposal are more varied and complex than those which have been solved in sewage treatment, and the cost of industrial waste treatment may be as great as that of completing the sewage disposal projects of the nation.

2. *Different Kinds of Industries.* In 1904, Los Angeles had 814 industrial plants with a total of 10,000 employees. With a steady growth, these plants increased to 3192 in 1937, with 77,000 employees. Among those industries where the liquid wastes have generally been discharged into sewers are the fruit, vegetable, and fish canneries, the creameries, dairis and ice cream plants, cleaning and dyeing establishments, laundries, overall and rag cleaning plants, breweries, cooperage, soap plants, meat packing and slaughter houses, and the wastes from garages and auto service stations.

Other industries which may have wastes that will affect the sewers are the gas works, marble works, oil refineries, chemical works, sugar refineries, bottling works, baking plants, wine plants, moving picture plants, paper plants, poultry dressing houses, and sausage casing factories.

3. *Division of Industrial Wastes into Groups.* As suggested some years ago (2), industrial wastes may be divided into four groups in connection with their disposal.

First: Those wastes which can be discharged into sewers without any preliminary treatment.

Second: Those which require some adjustment of the amount of flow, but no preliminary treatment before disposal into sewers.

Third: Those which can be admitted into sewers after some preliminary treatment of the waste.

Fourth: Those which should not be permitted to be discharged into sewers.

Where the volume of the waste does not materially increase the cost of sewer maintenance or the cost of sewage treatment, and where the waste has no injurious effect on the sewers or sewage treatment, such waste belongs in the first group.

Should the waste discharge into the sewer occur intermittently so as to overtax the sewer capacity, such wastes are in the second group, and such discharge should be controlled at a reasonable and uniform rate over several hours, or at specified periods. An illustration of this discharge is seen where sewer connections are desired from swimming pools and cooling tanks, when there are no storm drains in the vicinity into which such discharge could be made.

The third group includes those wastes which contain acids, oils, grease and other substances that would form deposits in the sewers, or overload the sewage treatment plant. When canneries in this group fail to provide the preliminary treatment required, the sewage treatment plant will frequently show evidence of skins and peelings that should have been intercepted at the plant of the industry.

In the fourth group are those industrial plants which discharge live steam, scalding liquids, volatile inflammable liquids or gases, and unpolluted cooling and condensing water that could properly be carried into a storm drain, if available. The discharge of such wastes in this fourth group should not be into the sewers unless the sewers are of the combined type which carry both sewage and drainage. Certainly no storm water can be permitted to be discharged into a sewer of the separate type.

The division of the industrial wastes into these four groups shows that, for each application from an industrial plant for a sewer connection, the character, quantity, and rate of discharge of the waste should be known, if possible, and that satisfactory arrangements for the waste disposal therefrom have been made before the plant is erected. Occasionally those who are planning the industrial plant have gone ahead with their project, and when the plant was erected, applied for the sewer connection, and then found that the existing sewer was too small.

4. *Amount of Wastes.* The amount of wastes varies with each industry and also among the various plants in the same type of industry. Sometimes the amount of waste in an industry may be less than the amount of domestic

sewage therefrom. However, for those industries listed in the first paragraph of Section 2 hereof, the volume of waste is apt to be more than the amount of sewage therefrom, and such conditions affect the capacity of the sewer receiving the waste.

In Los Angeles, laundries and other industrial plants have at times been established in residential districts, which generally have small sewers. This has caused the amount of waste to exceed the available capacity of the small sewer, and thus required the construction of an additional or relief sewer. Due to the much larger amount of solids in industrial wastes than are found in sewage, the disposal of industrial sludge is a problem as difficult and more costly to solve than occurs in sewage treatment. The size of a plant required for the treatment of a million gallons per day of industrial waste is larger and its work more complicated than that required for treating the same volume of sewage.

The volume of liquid waste from various industries in Los Angeles forms an appreciable percentage of the total flow of sewage. An estimate of the volume of laundry waste water gives an average flow of 12 M.G.D., that from meat packing plants and slaughter houses may have an average flow of 8 M.G.D., and that from creameries and dairies may have an average flow of 5 M.G.D. Adding to these wastes, those from breweries, overall and rag cleaning plants, and moving picture studios, will give a total volume of more than 26 M.G.D., which is 20% of the present average flow of sewage discharged into the ocean from the Hyperion screening plant.

5. *Analyses of Wastes.* (a) *Suspended Solids.* The suspended solids in sewage may average 250 p.p.m. by weight, but those in industrial wastes may average from 50 p.p.m. to 3000 p.p.m. or more.

In meat packing plants in Los Angeles, the content of suspended solids in the liquid waste may vary from 500 p.p.m. to 3000 p.p.m. Waste rag laundries have shown a variation in such content from 800 to 6000 p.p.m. Overall cleaning plants vary from 500 to 1100 p.p.m. Fish cannery waste has shown a variation from 2000 to 3000 p.p.m.

(b) *Grease.* The content of grease, or ether soluble matter, in sewage from 16 different cities was found to average 53 p.p.m., or .05 lbs. per capita per day. (3) The average grease content in sewage in Massachusetts was estimated at 97 p.p.m.

The grease content in the fish cannery waste has varied from 400 to 1000 p.p.m. In meat packing plants records from 600 to 900 p.p.m. have been noted, while in waste rag laundries grease content in the waste has varied from 600 to 3600 p.p.m.

(c) *B.O.D.* In meat packing plant wastes, the B.O.D. content varies from 600 p.p.m. to 1500 p.p.m. Breweries are next to meat packing houses in such content. A barrel of beer produces wastes whose B.O.D. is equivalent to the sewage of 20 persons.

6. *Harmful Effects of Wastes.* Concrete sewers are subject to deterioration from some industrial wastes, as acid pickling liquids. To prevent such action, the pH value of the waste must not be permitted to fall too much on the acid side of the scale. In Baltimore, Md., the city ordinances require that the pH content in the discharge from industrial plants shall not

be less than four. An English recommendation is to keep the pH of influents to activated sludge plants not lower than six for optimum results.

Oil refinery wastes affect water supplies, recreation and aquatic life, cause agriculture to be damaged by the brine in the oil, and should be evaporated or diluted before disposal onto land. (4) These wastes increase the chlorine demand, and the tastes and odors in the water supply.

The discharge of waste oil into the sewers is a serious matter, as it interferes with the proper maintenance of the system, and because the presence of gasoline coming from such discharge may cause an explosion or fire in the sewers. Such a result would affect the public health and welfare, as well as the sewerage system. As is done in Los Angeles, other cities should conduct explosive gas surveys in the sewer manholes in order that where the conditions are found to be dangerous, the gas companies can be notified and the trouble remedied. If the cause is from some source other than natural gas, efforts should be made to locate the source, and eliminate the cause.

Without the use of grease traps or intercepting basins, sewers have been clogged repeatedly by grease coming from industrial plants, or from places where food in large quantities is prepared for human consumption. Patented grease traps on the market, that guarantee high efficiencies, do not solve the problem when the grease intercepted is not removed from the trap. The remedy should be in periodic and frequent removal of the grease by those in charge of the premises, and a constant inspection by the City to see that this remedy is carried out.

7. *Control of Waste Disposal.* Some cities in the United States have laws prohibiting the discharge of certain industrial wastes into the sewers. In Fostoria, Ohio, the discharge of iron and carbon in wastes is controlled by the requiring of definite amounts of flow for varying content of iron and carbon in the wastes. These requirements will necessitate that the flow be gauged every two or three months.

The State Boards of Health in Pennsylvania, Connecticut, Rhode Island, Ohio and Massachusetts have power to enforce laws restricting the disposal of industrial wastes. However, it is preferable to have the state or city obtain the approval and cooperation of the industry, which has been done in Maryland, Michigan, Ohio, Pennsylvania and Wisconsin.

In Los Angeles, it is unlawful to discharge into any sewer or drain any liquid waste containing chemicals, grease, oil, tar, or other matter in solution which shall clog or fill the sewer or interfere with its effective use. It is also unlawful to discharge any liquid waste having a temperature greater than 100° F., or which shall contain more than 600 p.p.m. of oil or grease by weight, or which shall contain more than 1000 p.p.m. of suspended solids by weight.

These limits of permissible content of oil or grease, and suspended solids in liquid wastes discharged into any public sewer were proposed after a survey by the writer of existing conditions in the Los Angeles system in 1936. At about the same time (although then unknown to the writer) the State Board of Health of Massachusetts fixed their limits for these contents at 300 p.p.m. and 500 p.p.m. for grease and suspended solids, respectively, in the Essex County sewerage district.

In Madison, Wisconsin, the Madison Sewerage District requires that packing house wastes reaching the District sewage treatment plant shall have

no greater strength than domestic sewage. In Austin, Minnesota, the Hormel Packing Co. has a volume of waste equal to, or greater than the volume of City sewage, but the strength of this waste is much greater than the sewage. The Company is now planning to reduce this waste so that the effluent from its plant shall not contain over 600 p.p.m. of B.O.D., or 200 p.p.m. of suspended solids.

In Manchester, England, the permissible limits suggested for waste disposal from industrial plants are 428 p.p.m. for both grease and oil, and suspended solids.

To control to some extent the amount of grease and solids in the liquid wastes entering the Los Angeles sewers from industrial plants, studies have been in progress by the Bureau of Engineering of the City of Los Angeles for quite a time as to the benefit that could be derived by requiring all industrial waste to pass through intercepting tanks or clarifiers before discharge of the waste into the sewer. This preliminary treatment would require that the varying amounts of grease and solids that would be collected in the clarifier should be removed therefrom at proper intervals, so that the effluent would have its content of grease and solid thus reduced to an allowable limit. The dimensions of the clarifiers would vary with the type and size of the industries.

Sand traps not over two feet in dimensions have been specified in Los Angeles ordinances for some years. Such traps, however, are not of sufficient capacity to permit of any detention period required for the collection and removal of grease and solids in the wastes discharged thereinto.

8. *Sewage and Grease Tests in Los Angeles System.* In connection with the studies noted in Section 7 of this paper, the Bureau of Engineering of the City of Los Angeles has made periodical tests of the raw sewage at various manholes in the sewerage system of the city. These tests include the temperature of the sewage, its pH content, and the content of hydrogen sulfide, settleable solids, suspended solids (the latter divided into total and volatile content), and grease.

In connection with the determination of grease, a local committee of chemists has assisted this Bureau in studying the effect of various solvents of grease in tests of sewage, sewage sludge and industrial waste. This committee intends to present its findings in a report that will be published in some technical journal. It is thought that the procedure now given as a standard or its determination, can properly be revised, and such revision has been used by this Bureau.

To assist this committee, a questionnaire was sent recently to several sanitary engineers and chemists throughout our country concerning their practice and thoughts as to a revision of the present procedure for determination of grease content. Although chloroform seems to be the popular solvent in the central states, and petroleum ether in the eastern cities, the local committee favored the use of mixed hexane for the reason that this solvent would permit of the extraction of grease in the sample to be tested without drying the sample (as now required by the Standard procedure), and for the further reason that other solvents tend to remove hexane-insoluble substances which for the greater part should not be included with grease.

9. *Conclusions.* A start has been made in this country in solving the problem of industrial waste disposal. Our technical publications, such as the

Sewage Works Journal, Water Works and Sewerage, Sewage Works Engineering and Municipal Sanitation, and others, have devoted increasingly more space in their pages to this problem during each of the past four years. In its issue for November, 1939, the Industrial and Engineering Chemistry published thirteen papers on waste disposal presented at the Boston meeting of the American Chemical Society last September.

The Sanitary District of Chicago has for some years been studying this problem, although it has not as yet drafted an ordinance to cover the matter. In this study, the District has investigated over 210 different establishments for at least two weeks in each case to determine what discharge is taking place. It is possible that some report may be issued by the District on its progress in the matter by the end of this year. In this connection, it should be noted that the District has established legal control of its wastes by requiring that the District be paid by the industries for all volumes of waste exceeding 3,650,000 gallons in any 12 month period received for disposal by the District.

This idea of limiting the amount of the volume of industrial waste that can be discharged into a sewer without any especial charge therefor, will be a matter that should interest the City administration. If carried out, this might provide funds for the treatment and disposal of the industrial waste entering the sewers. Comments on this idea in recent proceedings of the Institute of Sewage Purification of England (6) state that "great courage on the part of local authorities will be required to determine whether or not to bring into force the whole of the powers which the Act provides. If carried out too much, new industries may be kept out; and if too little, some of the income to which the Act would entitle the City may be lost."

The Act just mentioned is the Public Health Act of 1937, and comments of English engineers as given in the "Surveyor" of Aug. 25, 1939, indicate that this Act had created certain prescriptive rights that would prevent local authorities from charging for all discharge into the sewer. "Proper knowledge of volume of trade effluent discharge must be had before such rights are determined." Expressions in the Act as "so far as is practical" and "without unreasonable cost" were considered too indefinite, as they do not make the Act water-tight. Some familiarity with this English law is recommended, as it has a bearing on the Illinois revised statutes that controls the payment for disposal of industrial waste into the sewers of the Sanitary District of Chicago.

Possibly the exact limits for the content of grease and suspended solids may depend on the relative volumes of domestic sewage and industrial waste. As the relative concentration of industrial waste increases, it may become necessary to reduce the permissible limits of grease and suspended solids. Thus the volume of waste is probably a factor that should be specified in the controlling ordinance.

The subject of financial returns from the recoveries of wastes by the industry should be considered (5). In meat packing plants and fish canneries, such recoveries cannot be overlooked, as the value of by-products is as important as the treatment of the wastes.

Most industries are assets to the community as they are taxpayers and give employment to many people. Accordingly the industry should be encouraged, and not driven away by unfriendly measures. However, the industry should conform to the laws in the operation of its plant, and in so

doing should bear a reasonable proportion of the cost of treatment of the wastes. The basis of determining such a proportion should include the relation of quantity of flow from the industry to the amount of flow in the sewerage system of the city, and the amount of suspended solids and grease in the effluent from the industrial plant must be given attention.

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DISCUSSION OF PROBLEMS OF INDUSTRIAL WASTE FROM THE STANDPOINT OF CITY ADMINISTRATION

By ALBERT CASTRO

Chemist, Santa Clara, California

As Mr. Knowlton says:

"Industrial plants that require some means of disposal for their wastes are willing that the City Administration shall look after such disposal." While it is true that there are different degrees, there are times the industry prefers to turn a deaf ear to the pleas from city officials for co-operation in solving the problem created by the dumping of their trade wastes into the city sewerage systems.

The definition of industrial wastes as defined by Metcalf and Eddy, "waste matters carrying suspended, collodial, and dissolved matters produced by manufacturing processes and discharged therefrom as being of *no commercial value*" might in itself be thought of as a sort of yardstick, for, as Mr. Knowlton points out, the value of recovery of by-products from an industry is a score which must not be overlooked. As is generally known it may be possible in many cases to reduce the amount of wastes dumped into the sewers by this means.

Besides the general division of Industrial Wastes into groups as given by Mr. Knowlton a good classification of industrial wastes on the basis of their qualitative nature alone and General Methods for their treatment can be found on page 352 of the 1938 edition of Modern Sewage Disposal.

In regard to those wastes which require some adjustment of the amount of flow alone, one set of jar experiments at the Santa Clara laboratory showed that in the case of wastes from prune and apricot packing the wastes could be mixed with the raw sewage up to the point where the percentage of the total volume for prune wastes was 5%, apricots 15%, a mixture of 50% apricots and 50% prunes to the extent of 5%, without the mixtures turning sour after standing 19 hours. With percentages above this, all were sour after this period of standing. Naturally too much emphasis must not be put on one experiment but if further studies permit us to draw the same conclusions as the first we may be able by controlling the flow of these wastes which are normally dumped into the sewers at about 5:00 p. m. in the evening, to eliminate the "turning over" of the contents of our clarifier which occurs regularly at about 7:00 p. m. every evening the packing houses are in operation.

Before a community decides what percentage of the additional costs necessary for the proper treatment of wastes from an industry should be borne by the

industry itself, there are many factors besides strength and volume of wastes to be considered in adding up the score. At the present time it can be only after carefully weighing the assets of the industry that a conclusion of some sort may be arrived at.

While it is true that the nature of the various wastes are as variable as the industries themselves and may vary for the same industry in different locales, State, if not Federal legislation setting up maximum strengths allowable for each general type of waste and a minimum fee per ton of wastes due a city for treatment of these wastes would, besides overcoming the present condition of industries being driven away from a community because of, as they feel, unfriendly measures, also help those communities which are at present shouldering the full expense of the treatment of these wastes.

PROBLEMS OF INDUSTRIAL WASTE FROM THE STANDPOINT OF CITY ADMINISTRATION

DISCUSSION

By **WILLIAM T. INGRAM**
Sanitary Engineer, San Joaquin Local Health District

I hesitate to comment on this excellent paper, but, on the other hand, I feel that the presentation of some recent investigations made in connection with the handling of waste solids from Stockton Canneries may be of some value and will, I hope, bring to attention further information along these lines.

The City of Stockton has an ordinance which prohibits the disposal of "any fish, fruit, or vegetable waste, or other solid matters, or materials or obstructions of any kind whatsoever of such nature or in such quantities as shall clog, obstruct, or fill such public sewer—or which will interfere with the efficient and successful operation of any sewage disposal works * * *." This ordinance has been used to affect some control of grease, gasoline and oil wastes, dry cleaning wastes, and many others, but complications enter when it is applied to cannery wastes.

In industries of this nature there is a certain spirit of competition. Chambers of Commerce, without full realization of the problems involved, frequently invite industry to a city which is not in a position to handle waste products in a satisfactory manner. I say this, not in a spirit of criticism, but as a statement of fact. There is much to be done in the field of education with such bodies as may be responsible for the building of a city.

With this background in mind, it seems applicable to a discussion of Mr. Knowlton's paper to offer a few bits of information concerning the use and design of screens as a means of pretreatment of cannery wastes.

In California, there is little information on the use of screens.

The Val-Vita Company, Fullerton, has a 5′ diameter by 10′ screen—using 5-16 mesh frames, 1-32 mesh frame, and 8-40 mesh frames. The speed of the screen is 24 r.p.m The waste flows outward and solids are collected and removed by a spiral conveyor. The screen is cleaned with a continuous water jet, and by steam three or four times a day. Operating at 11.4 tons per hour, this screen removed 450 gallons of waste from 125 tons. Suspended solids removal is estimated at 16%.

The U. T. C. Cannery, Buena Park, has a 3′ diameter by 11′ Rotary Screen. The plate is perforated with ⅛″ holes. Water flows outward, and the screen is cleaned by water spray. Solids are removed by spiral conveyor. This installation removes whole or broken tomatoes only, and one operates on a load of 7 tons per hour. Other data are incomplete.

Sutter Packing Cmpany, Palo Alto, has a flexible belt screen 12″ wide with ½″ openings, traveling at 8′ per minute. Flow varies from 400 to 700 g.p.m. Trouble has been encountered with clogging and cleaning. The installation

removes whole or sliced material and some skins. (See paper by Kimball & May, this Journal, for new data on this screen.)

Elsewhere, information is little more complete.

Cannery Waste Treatment Studies, conducted by Ohio Canners Association, and the Association of New York State Canneries, Inc., mentions 40x60 mesh rotary screens at 4 r.p.m will handle 2 g.p.m. per square foot. It requires 250 gallons of water per hour applied to screen to keep it clean.

Michigan Experiment Station Bulletin, Vol. 13, No. 4, mentions 40 mesh screens on average flow of 295 g.p.m. per ton of raw material, removed an average of 174 gallons per hour on tomato waste, containing 1.19% solids, with a screen 4′ diameter x 4′. The screw conveyor was not satisfactory and was replaced by a rotary pump. The speed of the screen was not given.

Iowa State Department of Public Health in correspondence indicates that rotary screens with 30 to 40 mesh give good service on corn, beans, carrots, and beets. Screens have been in service 2 and 3 years—no other data were given on screen sizes or speeds.

Illinois State Department of Health in correspondence mentions that size of screen is a matter of decision on each particular waste; principal wastes in Illinois are peas and corn. No conclusive data are available on rate of flow per unit of screen surface. Solids are removed by mechanical conveyor. High pressure water spray is desirable for cleaning, and pumping of waste prior to screening should be avoided.

A manufacturer in correspondence brings out these items: 20 mesh monel metal cloth is effective. 40 mesh clogs and necessitates oversize screens. Removals of 75% suspended solids on tomato and pea wastes may be expected on low solids concentration (600 to 800 p.p.m.), 50% to 70% removal may be expected on 2,000 p.p.m. suspended solids. Ordinarily, 25% removal would be considered as probable, and a 3′ diameter x 3′ screen, 20 mesh will handle 338 g.p.m. or 12 g.p.m. per square foot of screen surface. Speed of screen is variable, and is not given. Solids are removed by conveyor.

Another manufacturer using vibrating type of screens states that 2′x4′ 40 mesh screen at 2100 vibrations per minute will handle 300 g.p.m., or 37.5 g.p.m. per square foot of screen surface. Solids vibrate downward, and are removed by belt or conveyor. This necessitates a gravity flow on to the screen.

In a paper entitled, "Effect of Cannery Wastes on Operation of Sewage Treatment Plants" (S. W. J., Vol 12, No. 1, Jan., 1940), Ryan figured on a wet basis that 40 mesh screen will remove 30-35% suspended solids on tomato wastes. A shaker type, 60 mesh link belt screen has worked well at one large plant. (Type of waste not specified.)

The New York State Division of Sanitation in "The Treatment of Canning Waste," mentions that a 40 mesh screen is very satisfactory for most wastes, but 20 mesh should be used on tomato waste. 20 mesh is adequate when preceding chemical precipitation. 40 square feet of screen area was sufficient for 200,000 gallons per day. Screens require frequent inspection. A water spray and steam jetting are required when loaded at the rate of 3.5 g.p.m. per square foot of screen area. Speed of screen was not stated.

It may be that screening is necessary to remove solids from the waste, but it should be obvious that more effective removal is possible, if closer supervision of operation is practiced.

Reduction of waste can be accomplished if good quality materials are brought in from the field. Spilled juice, cuttings and wastes can be segregated at the plant if proper care is taken in the plant setup. The latter particularly applies to the waste products of the tomato pulper. At cleanup time, garbage wastes cleaned up separately or diverted out of the sewage flow would lessen the amount of solids in the sewage.

Summarizing this information, which I grant is incomplete, it is apparent that the use and design of fine screens is rather varied. It would appear that screens should be at least 20 mesh, and not over 40. Drum screens may handle flows from two gallons per minute per square foot of surface to 12 g.p.m. per square foot of screen surface. Vibrating screens may handle up to 37 g.p.m. per square foot of screen surface. Band screens may handle as much as 87 gallons

per minute per square foot of exposed surface, but clogging can be expected at this rate.

10% to 25% removal of solids may be expected, although both more or less have been reported.

Water sprays and steam jets for cleaning purposes should be provided in most installations.

Conveyors, pumps, or other equipment are necessary to carry the garbage waste away from the screen. The garbage waste may be eliminated at several points in the production process by careful operation and suitable equipment.

It does appear, however, that cities would be justified in requiring that garbage wastes should be removed from the sewers by some method. Close supervision and adequate equipment to divert such wastes in the plant are desirable as being a solution along more economic lines; for such waste once mixed with water is hard to remove, and not as easily handled.

If this cannot be done faithfully, then pretreatment, consisting of fine mesh screens constructed without by-passes, should be installed. Devices for macerating garbage waste should not be installed in any cannery.

CURRENT DEVELOPMENTS AND TRENDS IN SEWAGE TREATMENT

By **A. J. FISCHER**

The Dorr Company, Inc., New York, N. Y.

Future trends in sewage treatment will be largely influenced by current developments. These to a great extent are concerned with improvements to new equipment and processes that have been introduced during the past decade. Most of these have been publicized in the technical literature—a few perhaps too optimistically. Wide acceptance of new ideas, however, is generally a slow process and usually follows laboratory or pilot plant work, a representative full plant scale demonstration, and then the evidence of satisfactory operation of a number of typical installations.

Due to differences in sewage characteristics, the fact that a certain process works satisfactorily in one city or locality does not necessarily mean that it will be universally successful. Likewise, an occasional failure should not condemn a process or device as there may be extenuating circumstances affecting occasional plants. Sanitary engineers and public health bodies are as a rule conservative in evaluating new ideas because of the large number of questionable proprietary processes that have been proposed in the past. Such conservatism is, however, often extreme and in many instances retards worthwhile developments. The caution being taken in accepting high rate filters in some sections is an example of this ultra-conservatism.

On the other hand it is recognized that sewage treatment runs in cycles, and that these cycles are usually stimulated by intensive commercial activity along certain lines. The trend away from activated sludge treatment toward chemical precipitation, and then to high rate filters exemplifies this cyclic trend. This commercial stimulation is of benefit to the science of sewage treatment and has been responsible for a considerable portion of the major developments in modern sewage treatment practice. But, this activity often requires a brake, otherwise plants may be overburdened with unnecessary equipment that would be costly to operate, or a treatment process may be adopted that is inadequate to meet the local requirements. Just because

sludge incineration is satisfactory for Chicago or Buffalo is no reason why it should be adopted elsewhere where the sludge may be more economically hauled to dumps or used as a fertilizer. Similarly chemical precipitation may be adaptable in some plants where only seasonal treatment is required and where extremely low B.O.D.'s are not necessary, but may be entirely out of place where requirements are more exacting.

Regardless of how or by whom a process or particular piece of equipment is introduced in the sanitary field, it will not survive if it cannot show definite advantages. These advantages may be tangible, in that better results are secured or that savings in installation or operating costs will result. Or they may be intangible in that greater ease of operation, a better appearance, or elimination of odors, etc. are obtained. These intangible advantages are often hard to tie a dollar sign to, but nevertheless they are very real.

With these facts in mind, a more concise evaluation of past and current developments and their effect on future trends in sewage may be obtained.

Considerable progress has been made in unit operations and in processes or flow sheets comprising combinations of these unit steps. Of the former, the advances made in screening, aeration, trickling filters, effluent filters, digestion and various methods of sludge dewatering are outstanding. Likewise, major process developments have dealt with raw sewage flocculation, high rate filtration and sludge elutriation. Noteworthy work is also being done on improvements in grease removal, sedimentation, chemical treatment and sludge drying. Time would not permit a detailed discussion of all of these phases of sewage treatment. Moreover, in view of the excellent review presented by Dr. Mohlman in the February 1940 issue of "Water Works and Sewerage," such a detailed discussion would be superfluous in certain of its aspects. The intention here is rather to present the writer's opinions regarding the possible future outlook of sewage treatment in relation to past and present developments and present trends.

Screening

At an overwhelming number of plants being designed or under construction, sewage screenings will be ground and returned to the raw sewage. In the United States "Comminutors" are being used extensively for small plants, while separate screens and shredders appear to be favored for the larger installations. In England and Holland, where most of the sanitary activity in Europe has been going on since the outbreak of the war, a shredder pump known as the "Gargantua" disintegrator is being widely used, mostly in connection with mechanically cleaned bar screens. One form of this disintegrator is capable of delivering the ground screenings against high heads. Such an arrangement would be ideal for the preferable introduction of the screenings directly into a digester. Unfortunately, however, a large volume of liquid is necessary to convey the screenings through the unit so that this procedure is not practical.

Regardless of the type of screenings shredder employed, it appears that the quantity of scum in the subsequent settling unit is increased when the ground screenings are returned to the sewage. Greater digester scum difficulties have also been reported. Overloading of separate shredders is often encountered when a screen rake dumps its load. The operation of the screen rake, conveyor and shredder may be regulated by an interlocking timing device.

Grit Removal

Mechanical removal and washing of grit is being and should be more generally adopted in both small and large plants. Area rather than velocity is now considered the most important factor in grit chamber design. Proportionate flow weirs are unsatisfactory in regulating velocities in grit channels because although they maintain a constant average velocity, a relatively high velocity is set up along the channel floor. This velocity is often of such intensity that settling fine grit is carried out over the weir of the collecting channel.

Well washed grit is satisfactory for use as fill, for roadway surfacing around plants and as a substitute for sand in replenishing sludge drying beds.

Grease Removal

Preaeration of sewage for grease removal is now generally restricted to plants receiving considerable quantities of industrial waste such as cannery and packing house waste. The use of chlorine for increasing the separation of grease is being tried at a number of plants. To date there is no conclusive proof available that chlorine is beneficial in this step.

Regardless of the efficiency of grease separating tanks built to date, a considerable portion of the grease separated from sewage is released in the primary sedimentation tank. Efforts are now being made to secure an almost complete separation in specially designed skimming units.

Outside of California where grease and scum problems are more acute than in other sections of the country it is questionable whether grease skimming will be adopted in the future except possibly in a few of the larger plants, chiefly of the activated sludge type.

Clarification

Research work on clarification has been mainly along the lines of improving feed distribution and effluent take-off. A number of model tests based on hydraulic similitude have been made wherein dye detention periods were observed. Such tests while interesting are of little direct value in determining the effectiveness of a settling tank for removing solids. Tank surface area and not detention period is the chief factor that influences clarification. This is true in raw sewage as well as activated sludge settling. The present tendency is to use design overflow rates of not more than 800 gal./sq. ft./24 hrs. in small plants for all classes of settling. Overflow rates not exceeding 1200 gal./sq. ft./24 hrs. are frequently used for large plants.

Two stage primary settling such as is being practiced at Mogden, England, has been found to be only slightly better than single stage settling. In other English plants two-stage settling of activated sludge has been likewise found to be ineffective as far as the clarity of the effluent is concerned. However, a more readily settleable activated sludge has been obtained by returning only coarser sludge that settled in the first tank.

Raw Sewage Flocculation

It has been amply demonstrated and is now an accepted fact that mechanical flocculation will increase the efficiency of raw sewage clarification. Table 1 shows some typical plant results. At Ypsilanti, Cedar Rapids and Los Angeles, results directly comparable with plain settling were obtained.

TABLE 1

Plant Results—Raw Sewage Flocculation

PLANT	Detention-Hrs. Floc.	Detention-Hrs. Clar.	Clarifier Overflow Rate	Suspended Solids—p.p.m. Raw	Suspended Solids—p.p.m. Settled	% Removal	REMARKS	SOURCE
Ypsilanti, Mich.	0.40	1.87	805	155	66	57.4	Parallel Tests	Fischer & Hillman Sewage Wks. Jour. March, 1940
	0	2.31	790	155	82	47.2		
Cedar Rapids, Iowa	0.67	1.90	662	208	96	53.7	Parallel Test	Fischer & Hillman Sewage Wks. Jour. March, 1940
	0	1.90	662	208	126	39.3	Domestic Sewage	
Los Angeles, Calif.	0.50	2.0	.....	275	64	76.8	Parallel Tests	Smith & Studley Paper presented at Calif. Sew. Wks. Assn. May 20, 1940
	0	2.0	.....	286	91	68.2	Experimental Plant	
Denver, Colo.	0.33	2.79	628	145	43	70.0	1939 Plant	C. P. Gunson, Supt. Denver Sew. Disp. Plant 1939 Operating Report
	0.33	2.79	628	145	35*	75.8	Operation	
Cedar Rapids, Iowa**	0.58	1.67 ea.	733	490	143	70.8	Pre-settling ahead of flocculation & settling	Green & McIntyre Water Wks. & Sew. October, 1937
	0.50	3.00	440	517	112	78.4	Clarifiers in parallel after flocculation	

*Effluent after filtration through magnetite filters.
**Packing House Waste.

Tests have been made and are still under way to determine the effect of the addition of various types of sludge to raw sewage ahead of flocculation.

Striking results have been obtained where 2.0% activated sludge was added. Results are given in Table 2. These results indicate distinct possibilities for bio-flocculation wherein a small amount of raw sludge is activated and used as a source of return sludge. At Hilversum, Holland, the return of humus sludge in sufficient quantity to double the amount of dry solids in the feed to a combination type Flocculator-Clarifier, greatly improved the settling efficiency of trickling filter effluent.

TABLE 2

Effect of Adding Activated Sludge in Raw Sewage Flocculation

	Floc Time	Settling Time	Suspended Solids p.p.m.	% Removal*
Raw Sewage	0	0	368	------
" "	0	60	166	54.8
" "	30	30	103	71.5
Raw Sewage + Activated Sludge	0	0	497	------
" " + " "	0	60	132	64.0
" " + " "	30	30	44	88.0

*All removals based on raw sewage.

The fragile nature of raw sewage flocs cannot be over-emphasized. Great care must be exercised in transferring the sewage from the Flocculator to the Clarifier. Sudden change in direction, and velocities in excess of 1.5 ft. per second will at least partially undo some of the work accomplished by the flocculation step.

More benefit may be derived from flocculation by increasing removals at normal clarification periods and overflow rates than by attempting to obtain the same removals at lower detentions. Indications are that flocculation to improve the efficiency of raw sewage and trickling filter effluent settling will be used extensively in the future here and abroad.

Chemical Treatment

The boom days of chemical precipitation are over. This does not mean, however, that chemical treatment is a thing of the past, but rather that it has found its proper niche. It still deserves consideration where only seasonal or part time treatment is required, as an adjunct to biological treatment, where industrial wastes are discharged into the sewerage system, or for odor control.

It still remains a puzzle why alum is superior to ferric salts as a coagulant for some sewages while the reverse is true of others. It is equally strange that pre-settling reduces the coagulant requirements of some sewages while it increases that of others.

Carbonation of highly alkaline sewage has been found to reduce chemical requirements and also aids in subsequent biological treatment. Tests on sewage ozonation have been made and have given some promising indications where iron was present in the raw sewage. This method of treatment has

not been carried along far enough, however, to be seriously considered in future plant design.

As a rule chemical treatment cannot compete with biological processes in producing an effluent of low B.O.D. It can, however, produce sparkling clear effluents low in suspended solids.

Aeration

Large activated sludge plants have been of the diffused air type with average aeration periods of five to six hours. Small plants most usually use mechanical aerating devices. A considerable number of the latter have been of the combination type wherein the aeration and settling compartments are in a single tank. The trend is toward conservatism in establishing design aeration periods in the small plants, a minimum of eight hours being preferred. It is hoped that the days of impossible guarantees regarding power requirements and effluent standards are over in regard to mechanical aerators. Only two combination paddle wheel diffused air types of aerators have been installed recently. In both cases the paddles are in the last half of the tank.

Considerable attention has been given to "tapered" aeration. In one form, all the settled sewage is admitted at the head end of the aerator and the air is tapered, while in another the air is held substantially constant along the channel, but fractions of the settled sewage are admitted at various points along the first half of the aeration unit. Both methods have points in their favor. Attempts have been made, however, to mathematically determine exact air distribution, return sludge requirements, etc. Evidence to date indicates that all such formulae are empirical and are not generally applicable. Apparently the safest way to determine air requirements and distribution is by frequent dissolved oxygen tests at various points along the aeration channels. As a rule where about 2.0 p.p.m of dissolved oxygen are maintained, satisfactory aeration should result. Development work is now under way on an automatic dissolved oxygen recorder. Such an instrument should be of inestimable value to the plant operator.

There has been renewed interest in England regarding pressure aeration wherein the tanks are covered and a pressure higher than atmospheric maintained above the liquid surface. The theory behind this system is that the increased pressure increases the dissolved oxygen content of the mixed liquor and so increases the aeration efficiency. Claims have been made that detention can be reduced to one-quarter and air requirements to one-eighth. It is questionable whether comparative tests would show such advantages. Reports some years ago on a commercial sized unit in Germany were not too enthusiastic.

Should the progress in high rate filters continue at its present pace, the use of the activated sludge process will be restricted chiefly to large plants in the future.

Trickling Filters and High Rate Filtration

The considerable advances in trickling filter and distributor design, and the world-wide acceptance of "high rate" filters indicate that this method of treatment is here to stay. At present two high rate systems are being advocated. These are the "Biofilter" and the "Aerofilter." Biofiltration covers a system wherein filter discharge material is recirculated to a Clarifier ahead

of the filter. The Aerofilter covers a process involving the uniformity of application of the filter feed over the surface of the filter bed.

Another type of filter that has had a more limited use in the United States on packing house waste, is the "washable filter" wherein the filter unit is back-washed with air and effluent according to a fixed procedure when it becomes clogged. In England considerable success has been reported on the treatment of milk wastes by "reversible filters," where two filters are operated in series, the sequence of operation being reversed when the primary unit becomes clogged. In England, Germany and South Africa, "enclosed filters" have been built, wherein the filter bed was entirely enclosed, ventilation of the bed being obtained by a suction fan.

From representative data obtained to date, it appears that artificial ventilation of the bed is not required, at least where shallow beds or an adequate under-drainage system is provided. Also shallow beds are far more efficient than deep beds per unit of volume where both low and high rates of filtration are used. Filters should be rated on their capacity to remove B.O.D. rather than on the dosing rate of the applied sewage. Biofilter test data indicates that the B.O.D. loading varies with the strength and characteristics of the

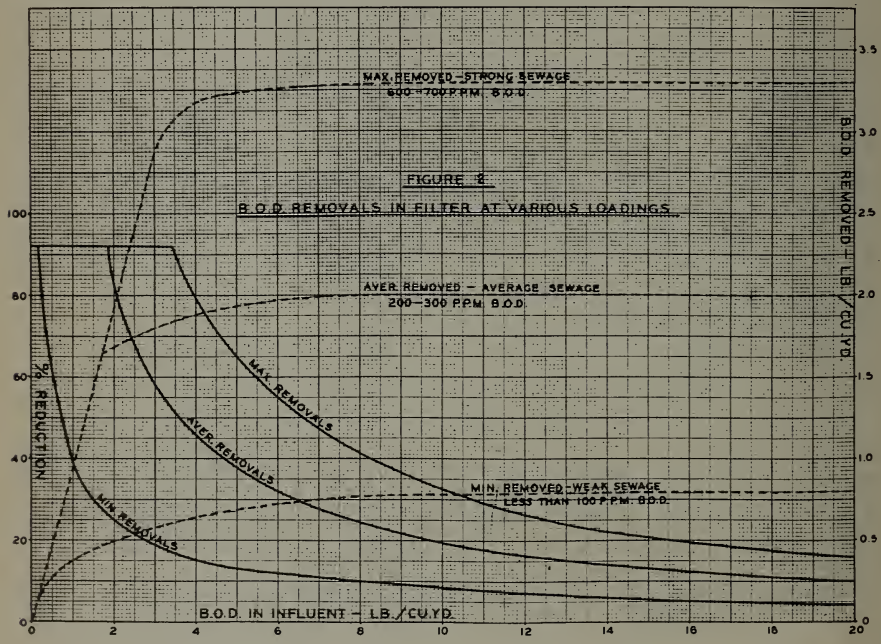

Fig. 2

sewage. Figure 2 shows B.O.D. removals at various loadings and with different strength sewages for filter beds three feet in depth. It indicates that the removals increase as the strength of the sewage increases. With distillery waste having a B.O.D. of 18,000 p.p.m., removals of 16 lbs./cu. yd./day have been obtained. Where very strong sewages are encountered or where a high quality effluent is desired, a two-stage filter system should be employed.

Such a system has recently gone into operation at Liberty, N. Y., where the sewage is very strong during the summer months. Although this plant has been operating less than two months, it has been turning out a satisfactory effluent with daytime raw sewage B.O.D.'s of over 500 p.p.m.

Distributors of various designs are now available that assure approximate uniformity of distribution under a wide variation in flow conditions. Provided the maximum permissible B.O.D. loading of the filter is not exceeded, satisfactory operation of the filter may be obtained at dosing rates up to the point where flooding of the bed occurs. With normal sizes of filter stone, this is 100-120 m.g.a.d. It is questionable whether there is any "twilight zone" between dosing rates of 4 to 10 m.g.a.d. where it has been reported that a filter will clog. To date no synthetic material has been produced that can compete economically with crushed rock as a filter medium.

Acceptance of high rate filters for large plants will probably be delayed pending the accumulation of long time reliable records of small installations.

Effluent Filters

Continued use of effluent filters is predicted where "polished" effluents are desired. Interest is also being given to the direct filtration of raw sewage and trickling filter effluents with and without pre-flocculation. It would appear, however, that at least a short period of preliminary settling will be required in the case of raw sewage. The most recent magnetite filter installation at Liberty, N. Y., is reducing the suspended solids and B.O.D. of the two-stage Biofilter effluent from 30 p.p.m. down to less than 15 p.p.m., while the turbidity is reduced from 10 p.p.m. to 5 p.p.m

Downflow circular magnetite filters have been found to be more satisfactory than rectangular or upflow circular units. Fine sand is preferred with average filter rates of 2.0 gals./sq. ft./min.

Sludge Digestion

Two-stage digestion with flexible piping systems so arranged that the digesters may be operated in parallel is the rule. The question whether or not mixing in a digester is beneficial is apparently still a controversial one. It is rapidly being clarified, however, by an ever increasing accumulation of data that tends to show that stirring is of benefit in increasing gas production and reducing scum. A new type of mixer, first installed at Yakima, Wash., showed that surface scum could readily be pulled from the periphery to the center of a 40-ft. dia. tank and submerged at very low power consumption. The comparative tests at Los Angeles showed the most striking differences in gas production with and without mixing. A survey of long time plant records compiled by F. G. Nelson has shown that it is difficult to correlate digestion results at different plants. Striking differences in gas production, however, were noted with and without stirring. These differences are shown graphically in Figure 3.

Interest in thermophilic digestion has been revived by the reports of the Los Angeles tests. Contemplated large scale operations will be watched with interest.

The digestion of activated sludge continues to be a problem because of the low solids concentration of the sludge after digestion, and the high solids content of the supernatant liquor. Some thought has been given to the elimination or minimizing of overflow liquor by concentrating the sludge

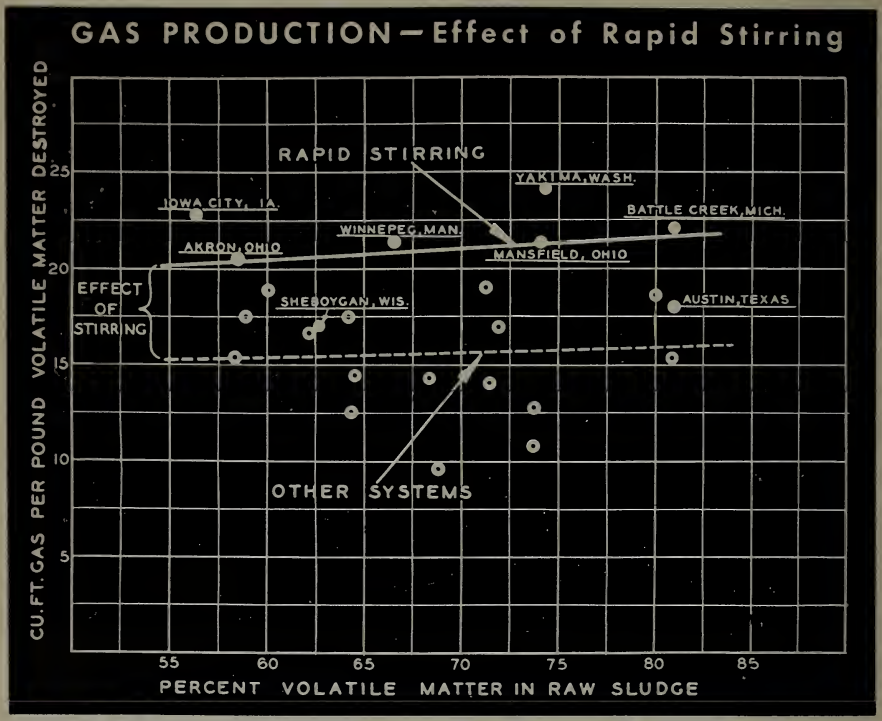

Fig. 3

ahead of digestion, or to the treatment of the overflow before it is returned to the plant. Upward filtration of supernatant liquor through a bed of ½" stone has long been practiced at Birmingham, England. Here the supernatant was heated to 72° F. and returned to the digester for the purpose of heating the digesting sludge. Whether this scheme would work with high solids in the liquor would have to be determined.

The Birmingham sludge heating scheme would not work if higher digester temperatures were required, as the solids contained therein would become colloidal in nature. External sludge heaters are becoming more popular in Europe but have not been widely adopted in this country. Should stage thermophilic digestion become established, it is almost certain that external heaters will be required.

"Dry" digestion or stabilization of raw sludge dewatered on drying beds or by filters or centrifuges is still in the experimental stage. This process is aerobic and thermophilic. It is doubtful whether it will prove commercially attractive in the near future.

Sludge Dewatering

The vacuum filter is still the preferred device for dewatering sludge. In small or medium sized plants, however, unless unusual conditions prevail, the use of anything but sand drying beds for dewatering digested sludge is questionable.

Sludge elutriation is being used to a greater extent. Its use is well justi-

fied on digested mixed sludges which ordinarily require very heavy doses of conditioner. The general inclination is away from primary raw, or raw mixed sludge filtration in favor of first digesting the primary sludge fraction. A plant is at present under design for Colne Valley, England, where the primary raw sludge will be digested, elutriated and then mixed with thickened activated sludge ahead of the filtration step.

In England a method of heat conditioning raw sludge ahead of thickening and dewatering by vacuum filters or filter presses has been developed. In this method the sludge was pressure cooked at 150 lbs. Advantages are that no conditioning chemicals are required, and high filter rates and low cake moistures are obtained. Disadvantages are that the process has many complications, is odorous, and produces a separated water high in B.O.D. that would require biological treatment. It is doubtful whether this process would be at all applicable in the United States or find any extended application abroad.

A considerable amount of experimental work has been carried out with centrifuges for the purpose of concentrating activated sludge ahead of digestion, and for dewatering raw and digested sludges for final disposal. For waste activated sludge concentration, it has been conclusively shown that thickeners are more satisfactory and economical than the centrifuges that have been tried to date. Chlorination is of decided advantage in the thickening step.

In dewatering raw and digested sludges the application of centrifuges appears to have limitations, due to the relatively high solid content of the centrifuge effluent. In the case of both sludges, the fine solids in the centrate will resettle when recycled to the raw sewage ahead of clarification.

It has been demonstrated at two plants that raw sludge may be satisfactorily handled without building up an excessive quantity of fines in the circuit or causing deterioration of the settled effluent. At both plants the plant removals did not exceed 50% and the sludge volatile matter content was normal. In the case of digested sludge, however, fines did build up in the circuit to a point where the recovery of solids in the centrifuge fell below the point of economical operation. Digested sludge or raw sludge that centrifuges with high solids in the centrate can be handled provided the centrate is not returned to the system or if only part of the total sludge production is centrifuged. A possible application is where existing sludge dewatering facilities are overloaded.

Open circuit test data obtained at Red Bank, N. J., on raw and digested sludges are shown in Figures 4 and 5. It will be noted that higher recoveries were obtained with the raw sludge.

A continuous type of solid bowl centrifuge, such as was used in these tests, is in operation at Cedar Rapids, Ia., for dewatering digested sludge. The cake is removed continuously from this unit by a spiral conveyor that rotates at a slightly higher speed than the conical bowl.

Sludge Drying and Incineration

Interest in sludge drying is mounting at the expense of incineration. This is due to the present market available for the sale of dried sludge as a fertilizer or as a fertilizer base. Experiences at Chicago and elsewhere should be ample evidence of the fact that where incineration is considered justified, provision should be made in the design of the incinerator unit for operating it as a dryer when occasion demands.

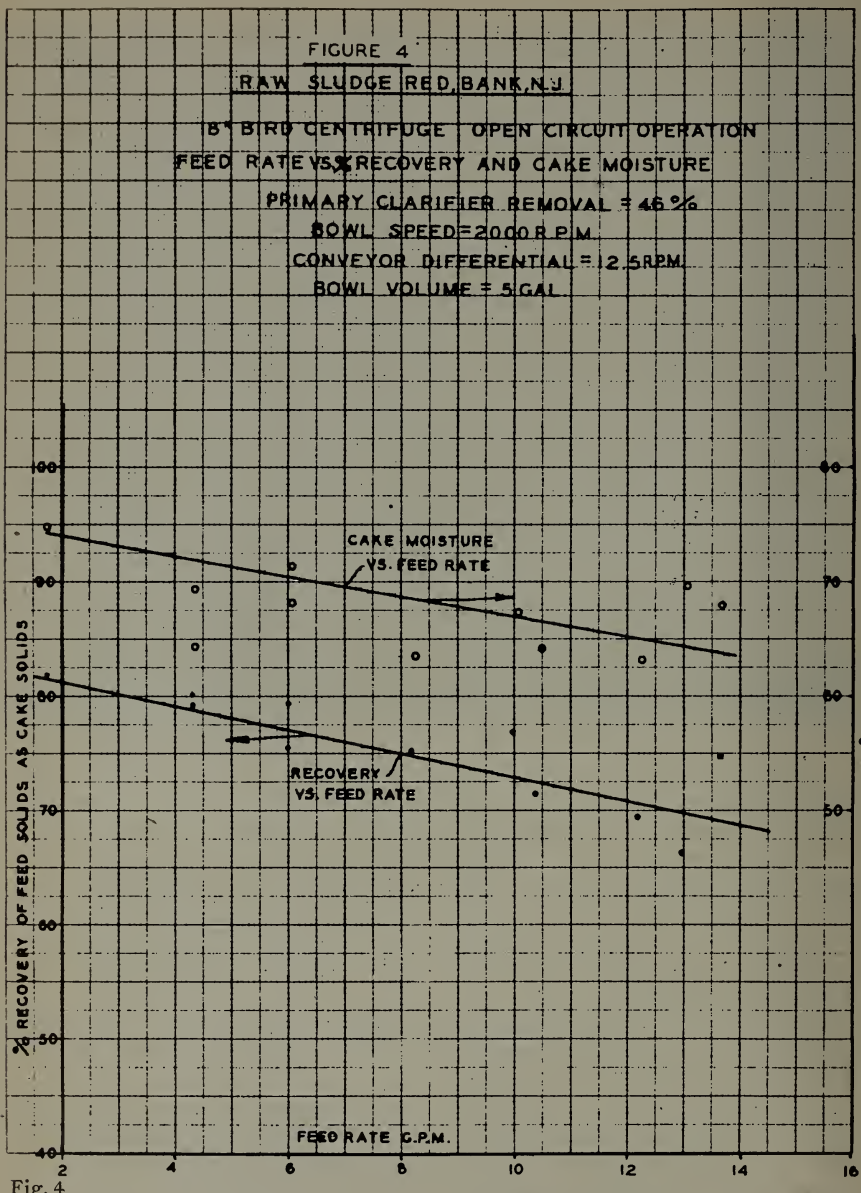

Fig. 4

All types of incinerators are costly to operate and require close supervision. Their use in small or medium sized plants should be avoided unless other means of ultimate sludge disposal are not available. However, where a cheap source of fuel such as digester gas is available, drying the sludge for use as a fertilizer may be justified even in small plants.

General Outlook

As no basically new methods of sewage treatment have as yet appeared

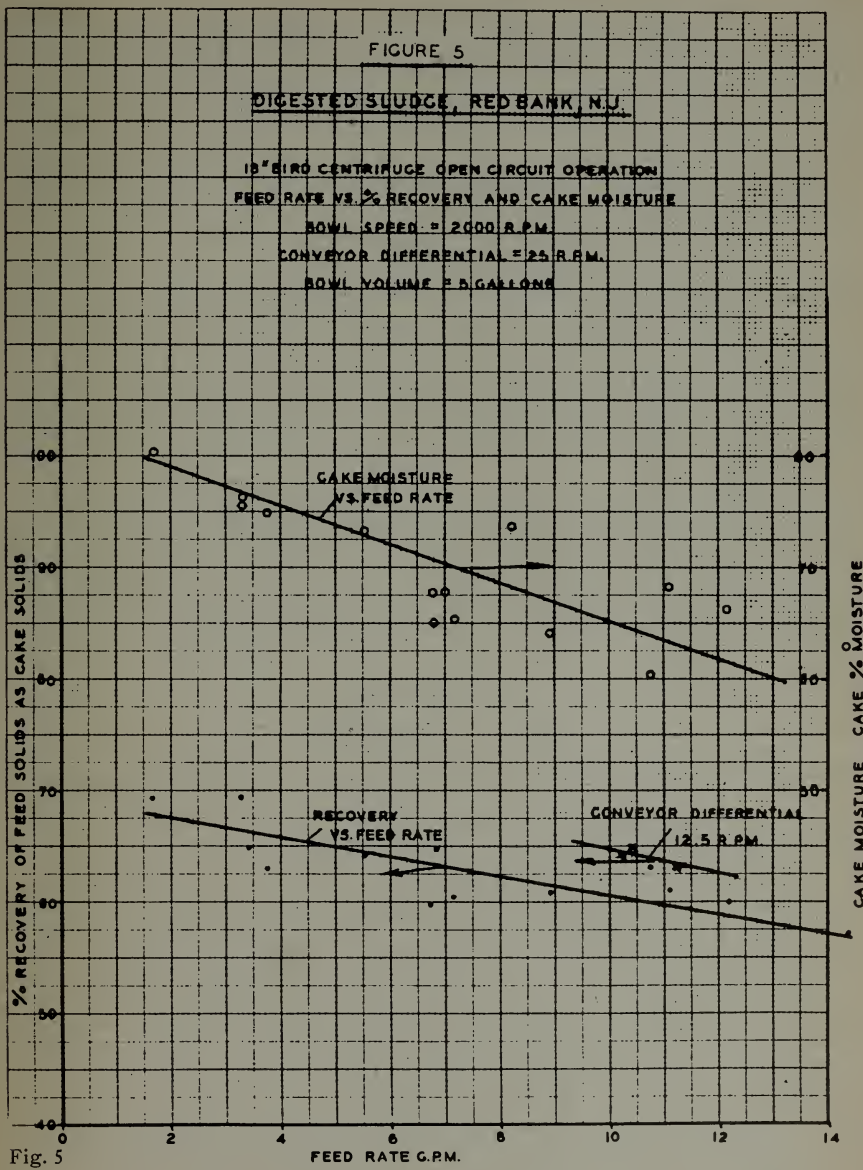

Fig. 5

on the horizon, it is possible that future trends and developments will continue along the lines of improving present unit operations and combining them in various ways. In the United States considerable emphasis will undoubtedly be given to the needs for small plants and improvements to existing installations. The number of new large plants to be built appear to be relatively few.

The rest of the world seems to be now definitely following our lead in all types of treatment. Progress has been slowed down in Europe due to the

war, but latest advices are that public works programs have been instituted in the occupied countries of Central Europe, chiefly in Holland, where plants using raw sewage flocculation, high rate filters, and sludge elutriation and filtration are being designed. In Germany there is a definite swing in opinion away from land disposal back toward biological treatment, but as far as is known, no new plants are at present being projected. The activated sludge process is still the most popular method of complete treatment in England, although considerable interest is being now given to high rate filters. Work on the partially completed activated sludge plants at Paris and Madrid has been resumed. The first modern treatment plant in Portugal, a combination chemical treatment-activated sludge plant at Braga is under construction. In South America a number of modern types of plants have been installed or are contemplated. These include plants with chemical precipitation, high rate filters and stage digestion. In Japan where activated sludge treatment has been used extensively, all sewage treatment plant construction has been halted, due to the war, but there has been increased activity in India and in South Africa.

Considering all facts at hand, it is apparent that there should be a construction boom in Europe and other foreign countries at the end of the present hostilities, and that a good share of this work will be allotted to sewage treatment plant construction. In this country where we have more direct interests, the general outlook should also be bright and will undoubtedly be bolstered by intensive activity in industrial waste treatment.

PAPER

By A. J. FISCHER

"Current Developments And Trends In Sewage Treatment"

Discussion *By* HAROLD FARNSWORTH GRAY,

Sanitary and Hydraulic Engineer, Berkeley

Dr. Fischer has presented an excellent exposition of the subject. There are however, a few points on which either an accentuation is desirable, or a different viewpoint may be useful.

He says: "Cycles are usually stimulated by intensive commercial activity along certain lines. The trend away from activated sludge treatment toward chemical precipitation, and then to high rate filters exemplifies this cyclic trend." It may be significant that the patents on activated sludge treatment ran out about the time the trend away from it began, and the trend toward high rate filtration began about the time that several patents were taken out on certain features pertaining to methods of application, recirculation, etc., though the basic idea of high rate filtration is probably not patentable.

The tendency has been for engineers of inadequate experience or training to slavishly follow the current trend in treatment, perhaps as the line of least resistance either to the importunities of equipment representatives, or to the demands of non-technical city fathers for the latest mode or fashion in sewage treatment. In the original manuscript of the Report of the Committee on Sewage Research of the Federation published in the March, 1938 issue of Sewage Works Journal I wrote (see page 190) "It is interesting to note that eight of the thirteen new plants on the Raritan River watershed are chemical precipitation plants, which indicates either a special adaptability of this process to that particular situation (perhaps a wide seasonal fluctuation in requirements) or possibly there has been a too slavish aping of the current mode in sewage treatment." However, Professor Phelps thought that the last clause of my statement was either tactless or

too emphatic, and that part of it was eliminated from the printed report. But as a generalization the criticism had and still has a valid basis.

The current trend needs to be viewed always with the cold eye of suspicion, for fashions come and go, but principles remain. Much of our difficulties in the field of sewage treatment lie in the unwillingness of public bodies, especially in the smaller cities, to support the expense and time and careful study required for really adequate analysis of all the conditions controlling any sewage disposal situation. Another contributing factor is the failure of some engineers to appreciate the necessity of making such adequate studies, of selecting the type of treatment process according to conditions rather than of fashions, and of having sufficient backbone to tell the city council, rather than of having the city council tell them.

With regard to screening, I am still unconvinced as to the advisability of returning ground screenings to the influent. If you have once taken the stuff out, why put it back? I feel that this matter deserves the application of better logic, plus some mechanical ingenuity.

Dr. Fischer states "It is questionable whether grease skimming will be adopted in the future except possibly in a few large plants, chiefly of the activated sludge type." I think that here he has failed to visualize the problem of disposal of large volumes of partially treated sewage into oceans, bays and estuaries, where grease removal may be desirable to reduce field visibility or to minimize beach or shore contamination.

My prior remarks concerning a too eager tendency to follow the prevailing mode or fashion in sewage treatment applies with special emphasis to high rate filtration, which Dr. Fischer has reviewed concisely and well. This is most important where large quantities of effluent are returned for dilution or the smoothing out of loadings. The added construction costs for the accessories such as extra settling basins, pumps, and piping, and added power, repair and maintenance costs, need further analysis and comparison. A very sceptical comparison of complete and accurate cost data is much needed here. The speaker is still far from convinced as to the long range economics of high rate filtration, in spite of the rather roseate picture painted in some reports. Furthermore, there seems to be need for a distinction between the functions of rock filters, both standard and high rate, as flocculating devices and as oxidizing devices. There is need for further investigation into these associated but perhaps relatively independent phenomena.

Dr. Fischer's last paragraph regarding a construction boom in sewage treatment seems to me to be overly optimistic. The current hostilities appear to me to be but one active phase in a clash of ideologies which may continue for possibly a century or more before a final settlement is achieved; peace will be merely armed truces as resting periods for recuperation in the main conflict. At the conclusion of the present active hostilities Europe probably will be too broke and too exhausted for much new construction in the field of sanitation, and the forward view is for a marked impairment of the public health as a result. In this country, the continuous piling up of all forms of public debt, even if we succeed in avoiding, for the present, actual war and its end results of panic and depression, will in the not too distant future result in the drying up of all forms of public credit, and the practical cessation of public works construction. It will also curtail industrial activity, and reduce any possibility of expansion in the field of industrial wastes treatment. Only a complete and utter pessimism is justified by the present outlook. Hell is loose in this world, and our generation may not live to see even its relatively short range results.

PROPOSED DISPOSAL OF SACRAMENTO SEWAGE

By CARL M. HOSKINSON

Chief Engineer, Division of Water and Sewers

The purpose of this article is to summarize the highlights of the findings and conclusions embodied in a "Report Upon the Disposal of the Sewage of

The City of Sacramento" prepared by Charles Gilman Hyde in collaboration with the Division of Water and Sewers in August, 1939.

The City of Sacramento operates a combined sewage disposal system which conducts sewage and storm water in a single system of conduits to two sewage pumping plants which are necessary to lift and deliver sewage and storm water into the river at all stages, due to the low elevations of the trunk sewers. Naturally, the volume required to be pumped is enormously greater during excessive storms than during dry weather. The two sewage pumping plants are Sump No. 1, built in 1907, and located at Front and U Streets, with a total capacity of 158 second-feet or 102 million gallons per day, and Sump No. 2, built in 1914 and enlarged in 1928 and 1939, located at 12th Avenue and Riverside Boulevard, which has an installed capacity of 694 second-feet or 448 million gallons per day. The present method is to dispose of sewage by direct pumping into the Sacramento River with no other treatment than coarse bar screening between sewers and pump suctions. For the year 1938 the total average daily pumpage at Sump No. 1 was 8.1 million gallons, and at Sump No. 2, 19.1 million gallons, whereas the July to November average was 5.8 and 14.2 million gallons respectively, both averages being at a ratio of 1 :2.4.

Sacramento's population in 1900 was about 29,000, and the 1940 Census shows a population of about 105,500. Other than those contributed by canneries, there are no important trade wastes discharged into City sewers. At present the cannery wastes impose a heavy burden of trade wastes to increase the pollution of the Sacramento River, and for several weeks during the summer have a biochemical oxygen demand considerably greater than the combined sewage and other industrial wastes of the City.

This cannery waste disposal to the City sewers occurs very largely during the summer period of low river stages. In addition, it has been the practice of the canneries to grind up their waste products and empty them into the sewers, but this practice has been frowned on by the State Commission of Fish and Game, and the waste disposed of in this way has been somewhat reduced during the past year. It is hoped and expected that such solid wastes will ultimately be entirely disposed of by methods other than discharging them into the sewer system, leaving only the waste liquors to be passed to the sewers.

Study of the present and probable future trends in sewer flow as related to population, indicates a present average sewage discharge for years 1929 to 1938 of about 17.6 million gallons per day from July to November. It is estimated that a plant to serve for 20 years, which is the suggested limit for anticipation of future needs, should have a capacity of 32 M.G.D. to serve a population of possibly 150,000 to 160,000.

The study and report on the disposal of Sacramento sewage naturally centers on the effects on the Sacramento River of discharge of treated and untreated sewage, both from the sanitary and esthetic viewpoint. The following points are covered quite thoroughly:

"Climatic conditions as related to sewage disposal in the Sacramento River; river stages and volume of flow; the river channel as related to capacity, bottom scour and navigation requirements; the volume of sewage flow at present and in the future; the character and composition of the sewage and

the effect of trade wastes, particularly cannery wastes, therein; the capacity of the Sacramento River to receive and innocuously dispose of the City's sewage considering the matters of visible effect, of oxidation of organic matter, of relief from sludge accumulations, and of the requirements of fish life; the possible steps which may be undertaken, with more or less rationality, to improve river conditions; the problem of rapid, effective diffusion of the sewage with the mass of river waters; the desirability of treating the sewage prior to discharge into the river; the times or reasons when treatment may reasonably be employed, the degree of treatment which would appear to be rational and economically or esthetically justifiable and the procedures best suited to the task of such treatment; rough general estimates of the costs of the steps and procedures discussed in the report."

The season under consideration for sewage treatment roughly covers a period of about six months from June to December, when the Weather Bureau river gauge falls to a reading of five (5) feet or less. In abnormally dry years such as 1931, a gauge height of five feet has been reached early in April, and such stages have continued to the end of the year, but for an average year the low stage of the river does not exceed seven (7) months. In rough figures a gauge height of 6 or 7 feet indicates a discharge of about 15,000 second-feet; a gauge reading of 4 to 5.5 feet, a discharge of 10,000 second-feet, and a gauge height of 2.5 to 4.0 feet, a discharge of about 5,000 second-feet, these figures being varied by degree of deposition of sand on, or scour of, river bottom.

The recreational season for boating and fishing on the river, as dictated by climatic conditions, begins in April or May and lasts until October or November.

The study shows that if any treatment of the sewage is contemplated, it will be "quite unnecessary with high river flows, and, in general, only justifiable, if at all, when the river is extensively used for recreational purposes."

When Shasta Reservoir comes into operation about 1944, the minimum flow in the Sacramento River at Sacramento will probably never be less than 5,500 second-feet, even during the dryest years, and this situation has a most pronounced effect on the sewage disposal problem, and has made the solution more simple. No matter what disposal practice is followed, it has been recommended that the effluent be promptly and thoroughly diffused through the mass of water in the river, throughout the entire year, except during the period of storm run-off.

The climatic conditions affecting the problem are indicated by warmer air and water conditions beginning in May and ending in October, during which time the river is used for various outdoor sports. The river water temperature, rising during this period, increases the capacity of the river to oxydize sewage because it increases the dissolved oxygen content at the saturation point, affects the growth of plankton, and general biological activity. Wind directions are important as regards the possible odor nuisance, and the prevailing direction for the summer months at Sacramento is from the south, and the average velocity for five years was 7.1 M.P.H., which is a velocity favorable to absorption of oxygen from the air by the river water. The rainfall naturally determines the amount of pumpage in a combined system, and the low river stages coincide with the period of no rainfall, as rainfall of any appreciable amount is rare in Sacramento between June and October,

inclusive. In this case, this is fortunate, since the storm run-off is so greatly in excess of sanitary flows, it would be infeasible to treat any quantity of sewage in excess of the dry weather sanitary flow. The Sacramento air temperatures are generally favorable to digestion of sludge in unheated tanks and drying of digested sludge on sludge-drying beds.

Attempts have been made by various sanitary engineers to set standards of river discharge per unit of raw sewage contribution and these have varied from 2.3 to 10.0 second-feet per 1,000 persons. For purpose of this study, a figure of 5.0 second-feet per 1,000 persons was assumed. In assuming any such figure the population equivalent of the industrial load should be included. With a standard of 5.0 as above, the population load for various rates of flow would be as follows:

With 1,000 second-feet, 200,000 persons
With 2,500 second-feet, 500,000 persons
With 5,000 second-feet, 1,000,000 persons

The State Engineers' reports of river flow have with remarkable uniformity indicated that for the 15 years from 1924 to 1938 the four months July to October have been the months of lowest estimated flow in the Sacramento River. Records show that the Sacramento River during the summer is on an average of 95% saturated with oxygen and this Report indicates that the necessary oxygen to prevent depletion to the danger point can be supplied by a flow of 1,800 second-feet past the City. Tests showed that with the ample flows at all times during 1938, the oxygen sag below the sewer outfalls was too small to be significant. A review of the tables of figures shows that during the 15 years 1924 to 1938 there were only 13 months when the estimated mean flows were below 2,500 second-feet. One table (No. 9) of the Report indicates the calculated flow of the Sacramento River during each of the five months, June to October, in each of the six years, 1930 to 1935, assuming the climatic conditions of those years to prevail, but with Shasta Dam in full operation. This period covers the dryest season on record (1931), other low run-off seasons, and one season of favorable rainfall and run-off. This table indicates an estimated minimum flow of 5,500 second-feet and a minimum average low month (August) flow of 6,420 second-feet. With such flow conditions established by the Shasta Reservoir, the maximum depletion of oxygen due to sewage and trade wastes, representing a population of 260,000 persons would be only 1.3 part per million, leaving a residual dissolved oxygen content of 6.8 p.p.m., or about 80% of the saturation value at the assumed river temperature. At all other periods the conditions of oxygen depletion would be much more favorable.

The minimum summer turbidity of the Sacramento River for years of maximum flow (1938) and minimum flow (1931) was exactly the same, namely, 20 parts per million, and the average summer turbidity for the years 1931 to 1938 for five summer months, June to October, was 25 p.p.m. Sacramento sewage has a typically gray color, and color of the river during low flow periods is very similar. Tests indicated that with dilution factors of about 50 to 1, the river turbidity is not increased by sewage discharged therein. The oily film on the river surface caused by greases and oils in the sewage can only be prevented by removing the bulk of this oil from the sewage prior to disposal in the river.

The chief characteristic of the Sacramento River water which assists the disposal of sewage is the amount of dissolved oxygen carried, and high degree of saturation. The average annual percentage of saturation from 1934 to 1938 ranged from 94 to 98 per cent with a mean of 96 per cent. From June to October of these years the mean was 95 per cent, with a range from 93 to 97 per cent. The river water also gains oxygen through reoxygenation by virtue of contact of the water surface with the atmosphere, and this process is aided greatly by surface ripples and light breezes. Another source of oxygen is the presence of plankton in the water, but this last source is not believed to be important in the case of the Sacramento River, due to the natural turbidity of the stream. It has been estimated that with a river flow of 5,500 second-feet at 75 degrees Fahrenheit, saturated with oxygen to 95 per cent, the oxygen yield would be 241,000 pounds per day, whereas with an assumed population of 160,000 persons in 1960, and with additional cannery load equivalent to a population of 160,000 more, the per capita five-day biochemical oxygen demand being assumed at 0.15 pounds per day, the total daily City demand would be 48,000 pounds, or only a 20 per cent depletion of the available oxygen in the stream. This would leave 6.5 parts per million of dissolved oxygen in the water out of an initial content of 8.1 p.p.m., with no resulting harm to fish life in the stream, which require approximately 1.5 to 2.0 p.p.m. for survival in fresh water.

POSSIBLE PROCEDURE TO IMPROVE RIVER CONDITIONS

The study and discussion lead to four steps which may be taken to improve Sacramento River conditions, even as these may obtain after the Shasta Reservoir is in full operation. The first three steps are manifestly desirable and the fourth is indicated mainly by esthetic and recreational reasons and by the natural desire to eliminate a possible nuisance, providing the cost is reasonable. The four steps or procedures as outlined in the Report are as follows:

"(1) Remove or divert from the sewers those solid waste matters which are naturally refused in a dry state, such as asparagus butts and spinach; also those naturally suspended in process and wash waters, such as tomato seeds, skins and the like.

"(2) Construct a connecting sewer from Sump No. 1 to Sump No. 2 to convey to the latter point all of the dry weather flow of sewage now delivered to the former.

"(3) Construct across the deeper portion of the channel of Sacramento River opposite or below Sump No. 2 a submerged pipe line with nozzles at frequent intervals to diffuse promptly and thoroughly throughout the body of water flowing in the river a volume of sewage equivalent to the maximum rate of flow of sewage contributed during dry weather at some proper future date, say the year 1960.

"(4) Construct a partial treatment plant to effect the removal of grease and oil and the heavier suspended solids from the sewage."

PRESENT STATUS OF POSSIBLE FUTURE WORK

Tentative approval has been given to the general plan proposed along the above lines, namely, to construct, if and when funds become available, a con-

necting sewer between Sump No. 1 and Sump No. 2, concentrating all dry weather flow at Sump No. 2, to pump the sewage from Sump No. 2 to a treatment plant to be located at some point downstream close to the east bank of the river, and there build a partial treatment plant, with grease and grit removal, sedimentation basins, digestion tanks, sludge drying structures and appurtenances, sterilization equipment if needed, and provision for passing the diffused effluent into the main flow of the Sacramento River.

Rough estimates of this work indicate the probable cost will be about one million dollars. No funds are at present available for this work, nor has any proposed bond issue for same been placed before the electorate of the City of Sacramento, but this preliminary study has been made, which, when so willed by the people, should lead to detailed design and, ultimately, to a more modern and sanitary disposal of the City of Sacramento sewage.

MAINTENANCE OF SEWAGE PUMPING PLANTS CITY OF LOS ANGELES

By FRED BATTY

Sewer systems are so designed and the sewer lines constructed on grades that will insure adequate velocity to carry the sewage to the ultimate discharge point.

The topography or other causes at various locations are such that the grades cannot be obtained to provide this velocity, so sewage pumping plants are constructed, at which the sewage is raised to a higher elevation, and where necessary, a force main of the required length is constructed, thereby enabling the sewage to proceed on its way to its final destination.

Los Angeles has 21 of these plants (two of which are for storm water only) varying in capacity from a few hundred to several thousand gallons per minute.

The types of these plants and the equipment contained therein is very varying. Some have been in use for many years. Others have recently been completed and embrace the latest improvements, and still others have been remodeled.

The personnel employed for the maintenance of these pumping plants consists of 10 Pumping Plant Operators, who maintain the plants assigned to them, on a prescribed schedule which varies according to the size and importance of the plants from a 3 times weekly visit to the smaller plants, to a continuous 24 hours a day assignments to the Venice Plant, which handles the sewage from the west portion of West Los Angeles, all the sewage from the City of Santa Monica and the Venice area of Los Angeles.

In addition to the 10 operators, an electrician and his assistant devote about 65% of their time in servicing the electrical equipment of the pumping plants.

Among the daily duties of the plant operator are the requirements:— That he shall test and throw in all switches on all pumps and see that all equipment is in proper operating condition; Clean and remove all rags from bar screens and wash down floors and walls around bar screens; Hose down wet well and keep the same as free from scum as possible; Change charts on

NAME OF PLANT	No.	GALLONS PUMPED (Millions) 1939-40	No. and Size of Pumps
Manchester	1	728.2	1-6", 1-8", 1-10" (6" and 8" have 2 speeds)
Union Pacific	2	92.8	2—8"
Mar Vista	3	87.6	2—8"
Fries Ave.	4	439.3	2—12"
Harbor Blvd.	5	37.6	2—4"
Ford	6	76.0	2—5"
Harris Pl.	7	39.3	2—4"
Fish Harbor	8	122.5	2—5"
Venice Sewage	9	2325.4	4—10"
Kinney Plaza Storm Water	10	170.1	3—20", 1-14", 1-8"
Thompson St.	11	10.7	2—4"
35th Ave.	12	34.0	1—4"
Terminal Way	13	706.1	2—10"
Airport	14	19.0	1—3", 1-4"
Malibu	15	104.1	2—6"
Lankershim	16	168.7	2—6"
Monon and Franklin	17	8.3	1—4"
Gravois	18	10.9	2—4"
Pico	19	5.2	1—4"
Hampden	20	.3 (7 mos.)	1—3"
Lankershim Storm Water	21	.6 (4 mos.)	2—4"
		5,172.7=14.8 M.G. Daily	

Operating Statement of Pumping Plants for Fiscal Year 1938-39

Million Gals. Pumped	K.W. Hours	Operators & Labor	Power	Light	Water	Plt. Rep. & Misc. Expense	Total Cost
4827	1,660,519	$27,646	$19,415	$1,256	$626	$14,629	$68,597
Per Million Gals.	344	$5.73	$4.02	$2.60	$1.30	$3.03	$14.21

recording instruments; Inspect and see that all mechanical equipment is lubricated with the proper type of lubricant; Inspect switch boards, motors and other electrical equipment, and report any deficient operation of the same; Inspect and clean floats and electrodes and thoroughly wash down guides therefor.

The operator shall see that all valves and gates are free and in operating condition at all times. Operators are instructed to open and close all valves and gates at least once a month.

It is very necessary at sewage pumping plants to keep all metal parts properly painted. The painting of plants, buildings and equipment is done by the plant operator.

A portable compressed air painting unit is available and where it can be operated efficiently, is so used. Other painting is done by hand. The following color schedule is standard practice:

1. Motor room floor and wainscot—grey
2. Upper walls and ceiling—Aluminum
3. Motors—Green
4. Pump (separate from motors)—Aluminum
5. Pump (attached to motors)—Green
6. Pipes and Valves—Aluminum

7. Switch Boards—Black
8. Stairs and stair rails—Aluminum

The operator makes minor repairs to mechanical equipment and is instructed to immediately notify the office when repairs of a more extensive nature are required.

He is also required to keep all pumps properly packed, and to keep the buildings, plant site and grounds neat and clean at all times; Shrubs, trees and lawns watered and properly taken care of.

A weekly report is made by each operator for each plant at which he works, and a duplicate copy of the report is kept at each plant for the information of the relief operators or their supervisors.

On this report a daily entry is made of the quantity of sewage pumped, power, light and water meter readings, K.W. used, number of times and length of time each pump operates; readings of recording instruments; time spent by operator on various kinds of work, etc.; weather conditions, time, duration and intensity of rains. Also remarks on type of sewage other than normal, variation of quantity of power used, speed of pumps or motors; irregular or faulty operation of mechanical or electrical equipment, etc.; work done by others than the operator, and any other information that might prove of value.

From these weekly reports a monthly office report is compiled. These reports, with other data, are used by the accounting division for ascertaining costs. All these reports and data are the basis for compiling the Annual report, which shows quantities and costs of all operations.

The repairing of the larger pumps is usually done under a requisition on one of the pump manufacturers, if possible by the manufacturer who originally supplied the pump.

The dismantling and reassembling of pumps and other equipment is done by the employees of the division.

The repairing of the smaller pumps and other repairing and any necessary work around the plant that the operator cannot perform is also done by the employees of the division.

The electrician and his assistant make the repairs to all electrical equipment excepting to the larger motors, etc. which they are not equipped to do. This work is done under inter-departmental orders by the Bureau of Water and Power.

The Venice Sewage Plant has an operator there continuously. The other plants are serviced by the operator assigned thereto daily, excepting two of the smaller plants that are serviced 3 times weekly.

All operators work on a basis of 40 hours per week, (other than at the Venice Plant) they work six days per week, working on a prescribed schedule of 6 to 7 hours per day (sometimes less on Sundays).

The six day a week schedule is accomplished by the operators doubling on their routes one day a week, thereby giving each operator a day off per week.

A relief operator relieves all operators for vacation periods, time off allowed for legal holidays, and for overtime allowed for additional work required during storms or for other purposes. No overtime is paid for.

Operators assigned to the care of more than one plant use their own cars for transportation, and receive the regular mileage allowance for the distance

traveled between plants. Routes are laid out along the shortest prescribed way. A table of distances between plants is furnished the operator.

These operators make their headquarters at the most important plant along their routes, where a telephone is available. Each operator phones his proposed route between plants and the time he expects to be at the various plants, to the office every morning, so that he can be located approximately at any time of the day. He returns to his headquarters plant on completion of his route. He receives no mileage between his home and his headquarters plant.

Operators work under the direct supervision of the Sewer Maintenance Foreman of the district in which the pumping plant is located and are also under the supervision of the Superintendent of Sewers and his assistant. An inspection is made of all plants by the superiors at least once a week, and the operator can get in communication by phone with the office, during office hours. Arrangements are made for operators to communicate with superiors during other than office hours through the City Hall Telephone Exchange.

The maintenance of Sewage Pumping Plants in under the direction of the Superintendent of Sewers, who reports to the Engineer in charge of Maintenance and Sanitation, who in turn reports to the City Engineer.

Recommendations

That all plants be provided with an overflow or by-pass, if possible, that no matter how well maintained and every precaution being taken to prevent accident, sometime or somehow a condition will arise that the sewage cannot be pumped, and if no overflow or bypass is available, sewage will either back up into private property or overflow into the streets.

That the plant be so constructed and equipment so arranged that the motors and switchboards, etc. are so located that there will be no possibility of their being flooded.

That the plant be designed without storage capacity, otherwise than the inflowing sewers themselves, when possible, and that continuous pumping be arranged for.

That the pumps be located in a dry chamber and that each unit be provided with shutoff valves on both suction and discharge sides so that each pump can be readily removed for repairs, etc.

That all pumps be provided with an arrangement for draining the sump that should be constructed in the pump chamber, and that the necessary valves be installed so that the sump can be drained, the stems of these valves should be carried up sufficiently high, so that in case of flooding, the valves could be operated. Small automatic sump pumps with motors at low levels are not satisfactory.

That the plant be arranged with ample room to work, proper stairways and adequate facilities for removing equipment be provided.

ELECTROLYSIS AT TERMINAL ISLAND

By G. A. PARKES

Conditions Discovered

During December, 1937, it became necessary to drain the digester at the Terminal Island Sewage Treatment Plant, in the harbor district of the City of Los Angeles, in order to repair the scum breaker arms, which had collapsed on account of heavy accumulations of scum.

The plant had been put in operation in September, 1936, and had been in service about 14 months. It treats the domestic sewage of San Pedro, Wilmington, and Terminal Island, as well as the industrial waste from two fish canneries in Wilmington. It is believed that the fish waste, high in oil and solids, caused the unusual amount of thick, tenacious scum.

On inspection, it became apparent that excessive corrosion and pitting had occurred on almost all of the metal parts which had been in contact with the sludge, liquor and scum in the tank. In some cases, pitting had penetrated to a depth of $\frac{5}{16}''$. In other areas extensive corrosion had occurred, varying from $\frac{1}{32}$ to $\frac{1}{8}$ of an inch. Several manhole steps, originally $\frac{3}{4}''$ in diameter, were eaten almost through, as were many of the iron hooks from which the hot water coils were suspended. It was found, however, that many of the steps and hooks and considerable areas of the hot water coils and steel rotating mechanism were unaffected. For example, one side of a structural steel member might be severely attacked and the other side of the same member entirely untouched.

The hot water coils also showed this "spotty" condition, some areas being badly pitted. Subsequent sand blasting, preparatory to painting, apparently perforated the thin places in the pipe at a few points. This was indicated by the presence of small amounts of sludge in the hot water system, when the digester was replaced in operation.

There seemed to be no zoning effect and no portion of the tank seemed to be affected more than any other. The concrete of the tank itself was not damaged in any way nor was there any indication that the reinforcing steel embedded in the concrete had been attacked.

The effects of the corrosion were so serious and had taken place in so short a time, that it was evident that unless the causes were discovered and eliminated, the entire mechanism would soon be destroyed.

Theories

Several theories were advanced as to the cause of the corrosion. Inquiries at the time failed to reveal any similar conditions elsewhere, although some cases of corrosion in digesters have been reported more recently.

The sludge was not altogether normal, due to the presence of the fish waste already mentioned, although the pH had been consistently above 7.0 precluding the possibility of acid corrosion.

Later investigation showed that the sludge and scum were high in ether soluble matter, and extremely high in chlorides. The latter, which was probably due to large quantities of sea water used by the fish canneries, has sometimes amounted to 2000 p.p.m. in the raw sewage entering the plant during the sardine packing season and for some unknown reason is concen-

trated to as high as 5000 p.p.m. in the sludge in the digester. These figures vary widely and average being about one-half the above. These facts, particularly the chlorides, undoubtedly had a bearing on the case, but were not known at the time the corrosion was discovered.

The theory that the corrosion was due to some form of electrolysis seemed to be the most reasonable and while the reconstruction work was going on in the digester, investigations were undertaken to determine the source of electrical current.

Alternating current is used for lighting and for power to operate the digester mechanism but all previous research has shown that such current is rarely, if ever, a cause of electrolytic corrosion.

A well known expert on electrolysis inspected the plant and gave the opinion that the corrosion was caused by stray direct currents from street railway operation. It was found, however, that there are no electric railways on the island and that there is no direct current produced or used in any appreciable amount. Furthermore, the only possible path by which such current could enter the plant was by the city water main. The water service pipe was disconnected and it was found that a higher electrical potential existed in the plant system than in the water main, indicating that the source of current was inside the plant rather than outside of it.

Investigations

At this time, the services of Mr. Otto Wiemer, Electrical Engineer of the Department of Building & Safety, were obtained, who, with the writer, made an extensive series of investigations as to the source of the electrical current.

A complete description of all the investigations would be far too lengthy to be included in this paper. Many experiments and unsuccessful attempts were made to correlate the electrical potentials which were found to exist between the different parts of the plant. Finally a method was decided upon, which for want of a better name, was called the "bench mark" method. This simply consisted of using one point, a conveniently situated water faucet, as a reference point and observing the potentials, i.e., voltages, of all other points in the plant, with reference to this one point. Several hundred readings were made and recorded showing values, positive or negative with reference to the "bench mark."

The equipment used for this work consisted of a very sensitive volt-ammeter, known as Rawson Junior "Multi-meter," with full scale readings in decade arrangements from as low as two millivolts to one thousand volts and from 0.1 milliampere to one ampere, several hundred feet of #12 rubber covered wire on a spool and numerous clips and points for making connections.

It should be stated at this point that during the reconstruction of the digester, the plant had been shut down and the contents of the digester transferred to the clarifier and decantation tanks for storage.

It so happened that most of the first readings were made at scattered points throughout the plant and showed only small voltages above or below the "bench mark." However, finally, a series of increasing potentials led to the clarifier, in which digested sludge was stored. Here a difference of four hundred millivolts or four-tenths of a volt was found between various parts of the clarifier piping and steel work and the "bench mark." Similar but

lower differences existed between parts of the decantation tanks and the "bench mark."

The investigation was continued and readings made of differences of potential between the "bench mark" and several hundred points throughout the plant. These points included hot and cold water systems, sludge pipes, electrical conduits, exposed metal parts in tanks, reinforcing steel in various structures and even hand rails and the wire fence around the plant property.

The readings varied over a wide range, positive or negative to the "bench mark" but from a study of all the readings, it became evident that greatest differences of potential existed between the point of reference and those tanks in which digested sludge was stored.

The only possible inference which could be drawn from these facts was that, in some manner, not entirely clear, the said tanks were acting as huge wet batteries and were actually producing electrical current. This current was leaking out through many inter-connected paths throughout the plant and was returning through other paths to complete the electrical circuit.

In applying this "wet battery" theory to the digester, which was not in use at the time, it was possible to conceive that the corrosion already described could have been caused in this way, provided the corroded parts were "anodic" or positive and some other parts were "cathodic" or negative.

It is well known that when two dissimilar metals are immersed in a proper electrolyte and connected externally, a current will flow from one electrode to the other and that one of the electrodes, the anode, will be eaten away. Such action is usually called galvanic action. It is also well known that it is not necessary to have entirely dissimilar metals, such as copper and zinc, for such a condition to exist. Even electrodes of the same material, such as iron, which by reason of difference in area, surface condition or partial protection, may be dissimilar, will behave in the same manner and one of the electrodes will be eaten away. A number of tests made in the laboratory, using numerous samples of iron and steel, and sludge liquor for electrolyte, proved that electrolytic corrosion could take place. One test was made with two small grids of black iron bailing wire of exactly the same size and shape. One grid was used bare and the other was cast in a plaque of concrete, one inch thick. Both grids were immersed in sludge liquor and showed a definite flow of current when externally connected.

A model was then constructed to simulate, in principal, the construction of the digester. The model was made of concrete, 16 inches in diameter and 12 inches high, with walls and bottom two inches thick. A cage of bailing wire was cast in the walls and bottom to represent the reinforcing steel, while a coil of wire supported inside the "pot" and in contact with the cage represented the hot water coils. The sludge stirring mechanism was represented by a grid of wire supported in the middle. Several wires were brought out for electrical connections and the "pot" was filled with sludge liquor.

Readings made with the sensitive voltmeter showed that current flowed through the instrument from the wire cage which was encased in concrete to the grid which was suspended in the liquor. This proved that the "pot" was acting as a battery and that a self-generated current passed from the wire grid anode through the liquor electrolyte to the wire cage in concrete, which was the cathode, and back through an external wire to the anode, thus

completing the circuit. Current also probably flowed from the wire which represented the hot water coil to the wire cage and back to the coil through the supporting wire, although this could not be proven.

However, after exposure for about three weeks, with the cage externally connected to the grid, a noticeable amount of corrosion was found to have occurred in the hot water coil wire as well as in the grid.

It was suggested that a possible source of electric current might be the maze of piping which connects the various parts of the plant. These pipes, of various materials, are for the most part, buried in the damp salty sand of the plant site and may, at times, be in brackish ground water.

This theory was based on the well known fact that pipes passing through varying types of soils are subject to electrolytic corrosion. In this case, the pipes buried in the ground would be cathodic while the other ends, being in contact with the sludge in the digester, would be anodic and therefore would be corroded. However, the experiments with the "pot" model, already mentioned, proved that current was produced when the model was standing on a bench and not in contact with the ground.

A test was made to simulate the condition of the above theory, with the "pot" partly buried in the sand and connected to a quantity of junk iron buried nearby. This sand was well soaked with ground water and conditions of current flow noted. It was found that a small current, probably not over fifteen per cent of the total, was produced by the buried iron and the remainder was produced inside the "pot." It was concluded that, due to the smaller relative area and to faulty electrical contact, the piping system of the plant would deliver but a negligible amount of current to the digester.

Electrolysis

After a very careful consideration of all the foregoing evidence, it was concluded that the corrosion which had occurred in the digester had been caused by an electrolysis due to a self-generated or galvanic current within the digester itself.

Further investigation was made to find the cause of the "spotty" condition of the corrosion in the digester, particularly as to why some of the manhole steps and pipe hangers were severely attacked and some were not. It was found by passing a small electric current from a flash-light battery through the various parts, that the steps and hooks which were corroded were apparently in good contact with the reinforcing steel in the concrete walls of the tank, while those which were not corroded were in bad contact or not in contact at all. This bad contact would prevent the completion of an electrical circuit without which electrolytic corrosion could not occur.

It could only be assumed that the "spotty" condition of structural steel members and some portions of the piping was caused by the fact that some of the original bituminous paint coating adhered to some areas and caused a concentration of current on the unprotected areas.

Considering the digester as a whole, the electrolytic conditions which could have caused the corrosion was now considered as being somewhat as follows:

The hot water pipes, being directly exposed to the sludge and therefore, by reason of their environment, dissimilar from the steel of the reinforcement, acted as anodes. Current flowed through the sludge electrolyte to the

cathodic reinforcing steel embedded in the damp concrete and thence back to the pipes through the supporting hooks which were in contact with the steel. The pipes, being anodes, were eaten away.

In the case of the sludge stirring mechanism, the structural steel members were also anodic and current passed through the sludge to the reinforcing steel. This steel, being in contact with the roof of the tank, itself of reinforced concrete with steel beams, passed the current to the rotating sludge mechanism through the driving machinery and thrust bearings, thus completing the circuit. Here again, the steel members of the stirring mechanism, being anodic, were corroded.

While the data obtained in the investigations did not definitely prove that the corrosion had been caused in the manner above stated, it seemed that all of the facts fitted the theory and that no other theory fitted all of the facts. It was therefore decided to proceed to devise protective measures on this basis.

Protective Measures

At first, an effort to insulate the various parts was considered. This would have been extremely difficult, if not impossible, and at best would have been unreliable, due to the many possible paths for the flow of current. It could not have been accomplished without extensive reconstruction of the tank.

It was decided to sand blast all of the exposed metal in tank and to cover the parts with a good bituminous coating. After sand blasting, the parts were given a prime coat of Wailes-Dove-Hermiston Corporation's "Bitumastic" solution, followed by two coats of hot "Bitumastic" enamel, mopped on. This material produces a thick, rather rough and brittle coating but when properly applied gives good protection. Such a coating however, on such surfaces, can not be applied so as to give 100 per cent coverage and it was realized that additional protection by other means would be required.

After considerable study and inquiry, it was decided to adapt the method known as "cathodic protection" which has for some time been used to protect oil, gas and water pipe lines from corrosion.

This method utilizes the fact that if a metallic surface, which would otherwise be anodic and therefore subject to electrolytic corrosion, be made cathodic by externally applied direct current, that surface can not be corroded and is therefore protected. This method is also sometimes known as "current drainage."

In the case of pipe lines, the pipe to be protected is connected by wire to the negative sides of some direct current power source, such as a motor generator set or a rectifier unit, the positive side of which is connected to a so called "sacrificial" anode, usually some sort of junk iron. The anode is buried in the ground at some distance from the pipe. Current coming from the power source, passes first by wire to the anode, then through the ground to the pipe, returning by wire to the source. The pipe thus becomes negative to the anode and the latter is destroyed instead of the pipe. Hence the name "sacrificial." The cost of replacing the junk iron anodes is small as is the cost of power required.

It must be understood that, while theoretically such a method should provide complete protection, due to the numerous uncontrollable factors en-

countered in the field, the conditions causing corrosion can only be mitigated to a large extent. In any case, the life of the pipe line is greatly extended and the cost of protection is well worth while.

While there was no precedence to be followed in the case of a sewage digester, it was felt that this method could be used to advantage, and would reduce, if not entirely prevent, the necessity of costly replacements in the near future.

Two anodes were provided, one being hung in each of the two manholes in the roof of the digester. These anodes were steel plates eight feet long, two feet wide, and one-quarter inch thick, suspended by two, one-inch diameter iron rods welded to the plates and supported from wooden frames in the manholes. The iron supporting rods were later found to be badly attacked and were replaced by two-inch by four-inch redwood hangers. The hangers were long enough so that the plates hung vertically in the upper zone of sludge with the tops about two feet below the surface. Heavy copper cables protected with heavy rubber covers were connected to the plates and carried out of the manhole top and across the roof to the central platform of the digester.

A Westinghouse "Rectox" rectifier, connected to the lighting circuit, provided direct current. The two anode cables were connected to the output or positive terminals of the rectifier. The return or negative terminals were connected to the main bus of a test panel.

In order to provide for definite return paths for current from the various parts of the tank to be protected, individual wires were connected to these parts and brought to the test panel. Connections were made to the hot water pipes at three points outside the tank, to all sludge and other piping, to the steel beams supporting the roof, to eight points in the steel reinforcement, to the driving machinery and by sliding brush contacts to the upper part of the stirring mechanism. In all, 32 such connections were made, each with its individual wire to the test panel.

The test panel consisted of a sheet of "masonite," about five feet high and 30 inches wide, in the center of which a brass bus plate was fastened. Mounted on the panel were 35 polarized porcelain receptacles one for each return wire, one for each anode cable and one on the main return to the rectifier. Each return receptacle was fitted with a homemade shunt, of three ampere capacity, across the terminals and on one side was connected to the main bus plate. Each return wire was connected to its respective receptacle. Twenty-five ampere shunts were fitted across each anode cable receptacle and a 50 ampere shunt was fitted across the main return receptacle.

Two ammeters were provided, each with cords and polarized plugs attached, one ammeter reading to three amperes positive or negative, the other reading to one hundred amperes, positive.

When the apparatus is in operation the circuit is as follows: Current leaving the rectifier passes through the anode shunts to the anode plates. Thence it passes into the sludge and to the hot water coils, stirring mechanism, reinforcing steel and other metal parts. From these parts it goes by the individual return wires to the receptacles on the test panel, and through the shunts to the bus plates. From the bus plate it passes through the main return shunt to the rectifier.

The purpose of the shunts is to provide for measuring of the current

without interrupting the circuit. The anode shunts permit the current passing to each anode to be measured separately. The individual shunts permit measurement of the current returning from each part of the tank to be protected, while the main return shunt provides for measurement of the total current returned and serves as a check on the other readings. The readings on the individual returns permit these circuits to be balanced in approximate proportion to the area to be protected, and also indicate whether the connection is in good condition.

The rectified has a capacity of 30 amperes at 3.2 volts direct current and is so designed that several combinations of voltage and amperage may be obtained but the tappings which produce 20 amperes at 2.2 volts are used. The total power used is therefore only that used by a medium size electric light. One-half the current is sent to each anode and the return circuits are balanced to carry from one-quarter to one and one-half amperes each. Readings are made periodically and recorded to note changes. The anodes are hoisted out for inspection from time to time and are replaced as needed.

When removed, the plates are found to be covered with a black honeycombed crust about two inches thick, while underneath the crust the plates are deeply pitted and eaten away at the edges. The wooden hangers are not affected. The crust does not seem to affect the operation of the plate as an anode. One pair of plates, originally weighing one hundred ninety-five pounds each, were found to weigh 90 pounds each, after 14 months of service. Each plate lost 105 pounds or seven and one-half pounds per month. This equals approximately 9.0 pounds per ampere per year. It is probable that the anodes should be replaced after nine to twelve months service.

Cost and Results

The cost of the installation was about $200.00, of which $140.00 was for the Rectox rectifier unit. This cost does not include labor, which was done by the plant operators, under the supervision of the writer.

Most of the electrolysis protection equipment was put in operation about the middle of December, 1938, using a homemade motor-generator set for power supply. The "Rectox" was purchased and installed later.

It is unfortunate that no definite information can be given at this time as to the results of this method of protection, as no opportunity has occurred to make a complete inspection of the interior of the digester. Three things, however, seem to indicate that the protection has been effective.

First, on May 5, 1939, after about five months of operation, an inspection was made of the scum in the digester and the upper part of the scum breaker truss was found to be in excellent condition, the Bitumastic coating being intact. This indicated that no serious corrosion was taking place in this part of the mechanism.

Second, a small amount of sludge was noticed in the hot water system soon after the digester was replaced in operation, indicating a small leak. The amount of make-up water required by the system has slowly increased but to date has not reached a serious amount. This is interpreted to mean that the leaks have not greatly increased as would have been the case if electrolytic corrosion had been at work.

Third, it is also felt that if the corrosion had continued at the alarming rate of the first fourteen months, some of the structural parts of the mech-

anism would have failed entirely in the nearly two years of operation since the protection was installed.

It was gratifying to note that, when for test purposes, the rectifier was shut off, the current in certain of the individual return circuits immediately reversed. This was exactly what was to have been expected from the results of the experiments with the "pot" model, indicating that the conclusions drawn therefrom had been correct.

As to the reason why this particular digester should have been attacked, while many other similar installations have operated for years without trouble, one significant fact stands out. The high chloride content of the sludge, already mentioned, is the only characteristic which differs from normal sludges elsewhere, and which is likely to have any bearing on the case. A saline solution is a good conductor of electricity and would provide a good electrolyte. It is possible, in fact, very likely, that in other plants where digester corrosion has occurred, it will be found that high salinities exist, due to industrial waste, saline ground water infiltration or presence of sea water.

In the near future, it is planned to install new sludge mixing equipment in the digester to convert it into the first stage of a two-stage system, using the decantation tanks as secondaries. When the tank is emptied for this work, a complete inspection will be made. It is hoped that the results of this inspection may be made public at a later date.

The writer is indebted to Mr. Wiemer for his assistance in the field and laboratory and the solution of the problem was in a large measure due to his wide knowledge of the fundamentals of electrolysis and electricity in general. Dr. Richard Pomeroy also gave valuable suggestions and advice.

The plant operators, particularly Mr. Fiscus, Chief Operator, deserve praise for their help and ingenuity in solving many problems of application.

DISCUSSION OF PAPER BY MR. PARKES

By RICHARD POMEROY

Electrolysis due to the coupling of two metals is well known to most engineers and others engaged in the mechanical arts. Less generally recognized is the fact that electrolysis also results from differences in solutions. The latter type of corrosion is far more common than the former, and is more important as a cause of corrosion.

The type of solution difference which is most serious is that which exists between aerobic and anaerobic liquids. If a piece of metal is exposed to both aerated water and septic sewage, and the circuit is complete, current will flow from the aerated water to the metal to the septic sewage. This was demonstrated at the California Sewage Works Associated Conference in Yosemite in 1935, when a battery was assembled with copper plates, water, and sewage. The current generated by this battery served to run a small motor.

If the metal is corrodable, corrosion will occur at the anaerobic, or anodic, location. This phenomenon is well known in pipe lines, and now we have this example at a sewage treatment plant, so carefully investigated and described by Mr. Parkes.

At the California Sewage Works Conference meeting in San Diego in the spring of 1938, when I discussed this corrosion problem, but without benefit of the subsequent electrical measurements, I expressed the opinion that the chief cathodic surfaces were on the pipes in the soil about the plant. We are indebted

to Mr. Parkes for showing that the reinforcing bars in the concrete may also be effective as cathodes.

Mr. Parkes has attributed the abnormal degree of corrosion in the Terminal Island plant to the high chloride content of the sewage. Undoubtedly this is an important factor, but I believe that an additional condition of significance was the sulfide content of the sludge liquor. Unfortunately no data were obtained on sulfide concentrations, but it is known that they were very high. In all of the other digestion tanks in which corrosion has been recently reported, dissolved sulfides are high, and in one of these cases chlorides are low.

It has generally been supposed that iron in digesting sludge or septic sewage will not corrode if it is isolated so that electrolysis cannot occur. Recent observations have made it appear likely that if sulfide concentrations are high, direct corrosive attack may occur, presumably with evolution of hydrogen. This is especially true if the pH is below 7.0. Evidently both electrolysis and direct corrosive attack must be considered in digestion tanks. We are happy that Mr. Parkes has shown so clearly the significance of electrolysis in one situation, and also the practicability of cathodic protection under such conditions. It may be noted that cathodic protection can be used to prevent or greatly reduce corrosion even if electrolysis is not the cause.

OPERATING DIFFICULTIES AT ESCONDIDO SEWAGE DISPOSAL PLANT

By **W. V. SKINNER**
Public Works Superintendent

It is my belief that most operating difficulties which have occurred during the life of our Escondido plant have been discussed at one time or another by other operators or engineers, both in papers presented, and at round table discussions at this Association and other Sewage Works Association meetings.

At our plant we have one operating difficulty in common with most other plants that have been in operation a few years, which is the most obstinate to conquer of any difficulty; that is the lack of funds for a comprehensive and continuous construction program to take care of needed extra units and rehabilitation of old units.

I believe that most operators will agree that it is not the quantity or character of the sewage they have to treat that presents their greatest operating problem, but it is the inadequacy of treatment facilities. This is generally true after the plant has been in operation a few years, and is not in most cases, the fault of the designers of the plant, but is due to the plant having to be designed to get the best results for a limited amount of money, generally raised by bond issue.

Our sewage disposal plant was put in operation in November 1929, designed for a maximum capacity of 375,000 gallons daily. The daily flow at the time being about 155,000 gallons. At the present time the average daily flow is about 300,000 gallons or an increase of nearly 100 per cent.

Several units of the plant have not lived up to their expected capacity, as they have been overloaded for the past three years. The units giving the most trouble are the sludge digester and clarifier.

The original bond issue covering costs of construction of the plant has only run about one quarter of its life, and in face of the fact that the plant was supposedly designed to operate efficiently for a few more years before reaching its maximum capacity it appeared impractical to place another bond

issue before the voters to raise funds for construction of the needed units. Therefore, the only other method of raising money would be by including sufficient money in the tax budget for this purpose.

The writer has called to the attention of the City Council at every opportunity the necessity of these improvements since before the time they were actually needed. But, in the face of other improvements of a more showy nature, such as Public Buildings, street work, etc., it was hard to even get the council to discuss any improvement at the plant until just recently, let alone do anything about it.

During a preliminary budget discussion this summer the writer suggested to the council that money could be borrowed from another fund for the construction of an additional digester to be paid back out of tax revenue for the ensuing year and construction could be completed before winter of this year. To my surprise the council agreed to this, and at the time of writing this paper it appears work will be underway by the first of September and we will have the badly needed digester before winter.

At the same time the council signified their intention of making improvements yearly instead of waiting until the plant had got so far behind that a bond issue would be necessary.

In closing I wish to state that I believe it behooves all plant operators to continuously attempt to educate City Councils, Sanitary District Boards, and the general public, to the wonderful service that is and can always be given in having safe and adequate sewage disposal, thereby making it easier to get needed money from year to year to make improvements on a pay as you go basis.

PUBLIC HEALTH CONSIDERATIONS REGARDING SAN DIEGO COUNTY SEWAGE DISPOSAL

By **G. C. ZUCKWEILER, Chief**

Division of Sanitation, County Health Department

In answer to the request of the committee of the California Sewage Works Association, I will endeavor to explain some of our sewage problems and how they were remedied, or will be remedied.

To explain the sewage problem at the international border which caused a dangerous and insanitary condition, it would be necessary to review the Tiajuana sewage problem back to a time when prohibition went into effect in the United States.

At that time Tiajuana was just a small village, but its population increased very rapidly and it soon outgrew its individual sewage disposal, such as privies and individual septic tanks. About 1924 a sewer was built in the business section and a small portion of the residential district, and a septic tank was designed and built to accommodate approximately 5000 people. This served the town well until about 1928 when many additional attractions were added across the border, such as Agua Caliente, the new racetrack, and the golf course. In 1930 the population of Tiajuana was estimated at 8000. At that time there was approximately 30,000 people crossing the International Border into Mexico on week-ends and holidays. Some remained at Tiajuana and the remainder visited other places of amusement, such as Agua Caliente race-

track and golf course. Agua Caliente and the racetrack have their own sewer system and sewage disposal plant. The effluent is disposed of into the sands of the Tiajuana River about three miles from the border. The transient population contributed to the already overcrowded septic tank at Tiajuana. As the tank was inadequate in size to allow the proper period of detention raw sewage passed through the tank and continued flowing across the international border along the dry river bed of the Tiajuana River, thoroughly saturating the sands of the river bed with sewage. Regardless of which direction the sewage was diverted, it would flow in the direction of some of the wells that furnished water for domestic purposes for the people of San Ysidro, as these wells were scattered all along the bottom of the river. In September, 1932, the sewage was flowing over all of the wells.

The Mexican officials were informed of the danger of San Ysidro's water supply becoming contaminated by the Tiajuana sewage and asked that the situation be remedied immediately. This was referred to the engineers, but the rapid change of administrations in Mexico prevented the engineers from carrying out any of their plans to remedy this situation.

The County Health Department ordered a chlorinator installed at the San Ysidro wells to safeguard the water supply. Water samples were taken regularly each day by this department and the analysis showed no evidence of objectionable contamination until September 16, 1932. From then on the analysis showed evidence of B Coli in every sample taken after September 16, 1932, until March 2, 1933. Then the wells began to clear up and have been negative for B Coli to date as our records show. During the trouble the people of San Ysidro were notified to boil their water, and there was no sickness during this period.

Our next course to pursue was to inform Governor Augustine Olacha that the situation had become an international health problem. Governor Olacha immediately saw the importance of correcting the dangerous condition and had money appropriated to build the present sewage disposal plant. The building of the plant did not entirely remedy the dangerous condition. It only moved the nuisance from one place to another. The effluent from the plant is highly septic as the plant was not carried out in every detail as originally planned. The effluent crossed the border about five hundred feet east of the international gate Number Two and flowed through several vegetable ranches where potatoes, beans and celery were grown. This caused a dangerous condition as it was almost impossible to keep the sewage from coming in contact with some of the vegetables although a ditch was dug through the fields that conveyed the sewage. This sewage flowed within 200 feet of the well that furnished water for a school house.

Apparently the only proper remedy was a trunk line sewer to the ocean, and a meeting was held on March 24, 1934 in the Mayor's office at Tiajuana, Mexico to discuss a trunk line sewer to the ocean, which would take care of the Tiajuana Valley sewage and that of the vicinity of the American side of the international border.

Those present at the meeting were M. F. Guerra, Mayor of Tiajuana, Mexico; Julio Devlia, Sanitary Engineer, Tiajuana, Mexico; C. G. Gillespie, State Sanitary Engineer; Doctor Alex M. Lesem, Director of Health, City and County of San Diego; B. B. Moore, Deputy County Surveyor; T. LeRoy Richards, Supervisor, and myself.

After some discussion it was suggested that the County Board of Health submit to the Board of Supervisors a request that they appoint a committee "which shall consist of engineers, surveyors and legal advisors or any other person interested, whose duty shall be to make a careful study and survey of the proposed sewage project." The data obtained was to be submitted to the International Boundary Commission for its approval.

After several meetings of the committee with representatives of the United States and Mexico, considerable data was obtained. This was presented to the International Boundary Commission and an agreement was reached whereby the United States Government agreed to construct a trunk line sewer down the Tiajuana Valley to the ocean on the United States side of the line.

The plans were prepared by the International Boundary Commission of the United States and Mexico at El Paso, Texas and on May 28, 1937 bids were opened and the contract was let. On March 25, 1938 Mr. L. G. Lawson, American Commissioner of the International Boundary Commission, notified the Board of Supervisors in writing that the United States portion of the Sanitation Project was completed and ready for acceptance. On April 3, 1939, the Board of Supervisors accepted and took over the operation and maintenance of the United States portion of the lower Tiajuana Valley sanitation project. Shortly after the Tiajuana Sewage Disposal Plant was connected to the trunk line sewer. The Mexican Government has agreed to pay 50% of the maintenance of the trunk line and outfall sewer. $2500.00 was budgeted for that purpose, $1250.00 by the Mexican Government, and $1250.00 by the County.

Now after 15½ years the insanitary, unhealthy, and dangerous condition has been corrected which is quite a relief to the County Health Department.

EL CAJON

El Cajon has a complete sewage plant built in 1929 and is located 1½ miles northwest of town. The plant is fairly well isolated and on high ground. It consists of a wet and dry pit, two 4″ American Vertical pumps, a clarifier, separate sludge digester roofed with loose planks, a trickling filter and final settling tank.

From the tank the effluent is pumped up on a hill and that which is not absorbed by the ground flows into a tributary to El Cajon creek, and forms pools of water, an ideal place to breed mosquitoes. The pools were always active with mosquito larvae and among the specimens we collected we found Anopheles.

While this plant is fairly well isolated, we have received numerous complaints from individuals and also two petitions complaining of odors and mosquito nuisances. The plant is kept painted and in good repair and has always presented a most credible appearance, yet to the people in that vicinity, it was still a sewage plant.

Ever since the plant was built I had tried to persuade the officials of El Cajon to plant trees all around the two acres of land that was donated to the City of El Cajon for the plant site and also to have a chlorinator installed for odor control.

About two years ago the chlorinator was installed and 18 months ago 1500 of the finest little Eucalyptus trees about 8″ in height were planted all

around the plant and today the trees will average 16 feet in height. They are watered with the effluent from the plant. There is no danger of roots getting into the sewer as it is 30 feet deep and was connected to the wet pit through a tunnel. There are three rows of trees planted diagonally 3 feet on center. Since then there has been no more complaints. The plant is almost hidden by the trees and resembles a park more than an unsightly sewage plant. As for the mosquitoes, we have oiled some of the ponds and stocked others with top minnows (Gambusia Affinis).

As a control measure these little fish are valuable in the suppression of mosquito breeding and may be introduced in shallow wells, water troughs, reservoirs, ponds and similar places, but this is the first time I have ever placed them in the effluent from a sewage disposal plant. Although there were gas bubbles all along the ditch there has been no evidence of Hydrogen Sulphide in the effluent. We have made tests at certain intervals and have not found even a trace. There have been over 100 cases of equine encephalomyelitis known as sleeping sickness among horses in our country and as the mosquito is under suspicion as a transmitting agent of this disease, we are doing everything possible to control the breeding of mosquitoes in the vicinity of the El Cajon sewage disposal plant.

CARLSBAD

Carlsbad had outgrown its individual sewage disposal and was very much in need of a sewer system. The town was infested with cesspools that were overflowing, causing a very insanitary and unhealthy condition, and there was very little room to dig new cesspools. It was obviously important that this town should make other provisions for their sewage disposal, and the citizens of Carlsbad were assured by outside interests that if the town was sewered, extensive building would be begun immediately. With this assurance, the sanitary district was formed. Its boundaries take in a territory that amounts to 1640 acres, with widely scattered population.

A modern up to date sewage disposal plant was built at the cost of $27,225 which reached the point of extravagance, with its many motors, pumps, patent clarifier, patent skimmer, digester with patent agitator, chlorinator and other mechanisms much too elaborate for the population it served. Such a plant requires an operator qualified to operate the plant in a safe and efficient manner and if any of these herein mentioned should be omitted, it would impair the efficiency of the plant.

Such a type of plant is very desirable for a city or large town but should not be erected in small populated sanitary districts such as Carlsbad, when a more simplified system could have been erected.

Those that assured the sanitary board of their support were among the heavy delinquent taxpayers. Delinquent taxes and equipment in need of repair, placed the sanitary board in a position where it was obliged to discontinue the operation of the plant and by pass the sewage around the plant into the outfall sewer. This caused an insanitary and unhealthy condition upon the beach. It then was necessary for the sanitary board to ask for a W.P.A. project to change the design of the plant. This was granted and the clarifier was dismantled and converted into a septic tank which operates by gravity.

All of the equipment was carefully removed from the clarifier without

being damaged. It was painted and stored and can be reassembled should it ever become necessary. Before the plant was changed, the cost of operation and maintenance averaged around two thousand dollars a year. For the past six years, since the plant has been operated by gravity, the cost has been practically nothing. Once every six months the sludge is drawn off and disposed of through the outfall sewer and requires about four man-hours to do the job.

LA MESA

All of the complaints received by the County Health Department relative to nuisances caused by sewage disposal plants in the County of San Diego are relatively small compared with that which we received from the general public and nearby residents in the vicinity of a ditch which convays the La Mesa and Rolando sewage along Chollas Canyon. This ditch parallels one of our main highways for approximately 2½ miles and is a breeding place for mosquitoes. The hydrogen sulphide is quite offensive and the mosquitoes are pests.

The engineer and the officials of the City of La Mesa are actively engaged in endeavoring to have the sewer system of La Mesa connected to the City of San Diego. The population of the City of La Mesa is 3912. Sewage from approximately 60% of the area within the city's boundaries is treated in an Imhoff Tank. The solids are disposed of as fertilizer, and the effluent is discharged in an open ditch in Chollas Canyon.

The plant was originally designed for a population of 750 and for the past several years has been over taxed. La Mesa's chief problem has been to make provisions for the increasing population and also for a permanent disposal of either raw or treated sewage so as to eliminate the discharge of effluent in an open ditch.

La Mesa was confronted with the choice of either constructing an adequate modern treatment and disposal plant or of making some arrangement with the City of San Diego for the discharge of sewage through the San Diego system. The estimated expense of construction and operation of adequate modern treatment plant was apparently beyond the city's resources so the council concentrated upon the alternate of connecting its sewer system with that of the City of San Diego.

While the City limits of the City of San Diego adjoins those of the City of La Mesa in certain areas, the best location for an outfall line from the City of La Mesa would require that the line pass through a portion of San Diego County before entering the City limits of the City of San Diego and connecting with the City's sewer system. It was estimated that in the event the line could be constructed with assistance from the Works Progress Administration of the United States Government, the cost to La Mesa would be approximately $35,000 and on May 22, 1939 an election was held for the purpose of authorizing General Obligation Bonds of the City of La Mesa to the sum of $35,000, to finance this cost to the City. This was presented to the voters and received a very favorable reaction carrying by a vote of 423 to 23.

Having assured the financing of the construction, La Mesa's next problem was to secure rights of way from the County of San Diego and the City of San Diego and permission from the City of San Diego to connect with the

City's sewer system. La Mesa receiving splendid cooperation from the County of San Diego, obtained rights of way through the territory within the county through which the line must be constructed for a consideration of $1.00. The City likewise was given every encouragement by the City Council of the City of San Diego.

A serious problem immediately developed, however, with the City of San Diego because of the fact that the discharge of the sewage from the City of La Mesa would increase the pollution of San Diego Bay which has been a source of conflict between the City of San Diego and the 11th Naval District and also with the State Board of Health. The City of San Diego proposes to construct a sewage treatment and disposal plant for the treatment of a portion of the San Diego sewage and in the negotiations between the two cities it was suggested that La Mesa should participate in the construction and maintenance of such a plant. In the meantime, pending its completion, La Mesa was to continue its own treatment in its Imhoff Tank and discharge nothing but effluent into the sewer system of the City of San Diego. This proposal was referred to the officials of the State Board of Health and also those of the 11th Naval District and received the approval of both organizations, providing the City of San Diego would immediately undertake the construction of a treatment plant.

San Diego has now made arrangements to finance the construction of the first unit of such a plant and an agreement was arrived at between the officials of the two cities for the participation of the City of La Mesa in San Diego's plan. This agreement provided for the following:

The City of San Diego agreed to secure rights of way for the location of the proposed outfall from the City of La Mesa within its boundaries giving to the city of La Mesa without other consideration, the right to construct an 18″ outfall line within such rights of way. That portion of the line laying within City of San Diego, however, to become the property of the City of San Diego upon completion. This line when completed was to be connected with that of the City of San Diego at a junction of Federal Boulevard and Home Avenue. Until the completion of the proposed treatment plant by the City of San Diego, La Mesa is to continue to treat its sewage through its Imhoff Tank, discharging effluent only into the San Diego line.

The cost of the construction of the treatment plant by the City of San Diego was estimated to be $406,000, and it was estimated that the proportionate share of the City of La Mesa in the cost of construction based upon the percentage of use by the two cities would be 5% or a total of $20,300, which the City of La Mesa will pay to the City of San Diego in ten annual installments without interest; the payment to begin in May of 1941, without regard to when the plant might be constructed by the City of San Diego.

It was further estimated that the cost of operation of the plant would be $10.00 per million gallons of treated sewage, and the proposed agreement provided that the sewage from the City of La Mesa would be metered into the plant and that the City of La Mesa would pay monthly to San Diego an amount equal to $10.00 per million gallons of sewage delivered by the City of La Mesa into the treatment plant. Such payments, however, are to begin at such time as the plant is actually constructed and in operation.

It was also agreed that this maintenance and operation charge should be

adjusted at five year intervals after the plant was in operation on a basis of actual cost of maintenance and operation of the plant.

As such an agreement placed a financial burden upon the City of La Mesa, it was necessary that it be submitted to the voters of the city for ratification before it would be binding upon the city. An election for that purpose was held in La Mesa on June 16, 1940, again receiving the indorsement from the electors of the City; the agreement being approved 340 to 14.

The agreement has now been executed by both cities and the City of La Mesa is now preparing an application to the Works Progress Administration for the approval of a project for the construction of the line. After such approval is secured, La Mesa will immediately begin construction of its sewer line. In the event that they fail to secure the approval, then La Mesa will attempt to construct the line without the Works Progress Administration assistance.

SEWER MAINTENANCE PROBLEMS AT STOCKTON, CALIFORNIA

By LYLE PAYTON, City Engineer

The maintenance of a city's sewerage system is a municipal problem which varies greatly amongst our California cities. The amount and character of sewerage maintenance depends upon the design of the system, the materials of construction, the gradients of pipe lines, effectiveness of automatic flushing, and efficiency of the maintenance crew.

Communities built upon the steeper slopes of foot-hill lands and ocean shores have perhaps few of the ordinary maintenance problems except failures of pipes and structures. Our inland valley cities, however, have those same problems plus the troubles arising from the fact, that minimum velocities are not obtainable in many of the lines of their sewerage systems.

Stockton is such a valley city, lying as it does on the edge of the San Joaquin River delta. Its terrain is very flat. Ground elevations U.S.G.S. datum vary, from four feet to 16 feet above sea level. Ground slopes are not more than four feet per mile. The sewage plants lying about a mile outside of the city, are on land at sea level elevation, and surrounded by protecting levees.

The Stockton sanitary sewerage system of 155 miles of pipe lines, 1,585 manholes, 1,055 flush tanks, and the storm water system of 75 miles of pipe lines, 1,121 manholes and 3,002 catchbasins, is maintained by a crew of four men using the ordinary tools of the trade.

The personnel of this crew is one man less than the pre-depression number of five. For this reason, they cannot do all of the necessary maintenance. Annual catchbasin cleanup must be done by street cleaning crews or by S.R.A. laborers.

The first requisite of the maintenance crew is a ready reference map record of the sewerage system. We have large scale block book records of the sanitary and storm water systems and also a block book record of all house branches, and tees and wyes for house connections. We are combining

these two records on tracing cloth so that duplicate prints can be made and furnished to the crew for reference use at their headquarters.

A sewer crew to operate efficiently must have good equipment suited to the kind of work they have to perform.

Our crew is provided with a one and one half ton canopy top truck, equipped with tool boxes and tool carriers. The following special equipment is carried or is available at headquarters; a turbine sewer cleaning machine; 400 feet flexible steel sewer rods; 300 feet wooden sewer rods; 300 feet 2½" hose with turbine and other nozzles; safety belt, flame gas detector, nose mask, small hand tools, boots, waders, etc., sufficient for four men.

Flushing is considered to be essential to keep a sewerage system with flat gradients in good running order, yet due to curtailed maintenance funds, Stockton has reduced the number of operating automatic flushers from 1054 in 1929 to 61 in 1934, thus reducing yearly water service costs from $8,500 to $710.

The first step in this reduction of active flush tanks was to discontinue the use of flushers on lines having a computed velocity of more than 1.5 feet per second. This reduced the number of operating flushers to 308 and the cost to $3,545 in the first year.

The maintenance crew then by experiments over the next four years reduced the number to 61 in 1934. The savings thus effected amounts to $48.70 per mile of sanitary sewer.

We have not experienced any material increase in the number of sewer stoppages, as is attested by the fact that the maintenance crew was reduced by one man in 1931 and he has not been replaced to date.

There are two districts, where sewers were extended beyond the limits for which they were designed, which require weekly inspection, but no unusual trouble has resulted from discontinuing flushing.

The number of stoppages in house branches between the main and the property line amount to 400 per year in round numbers, and in main and lateral sewers to about 100 per year.

The history of the last ten years of sewerage system stoppages indicates that they are the result of failures to comply with the existing laws and common sense.

Perhaps the worst offender is the operator of the automobile grease and wash rack. He equips his sewer outlet with a proper kind of mud and grease trap, but fails to clean such traps until a stopped storm sewer tells him, the trap has been full for many days and the mud is overflowing into the sewer.

The bottling works is another offender. Broken glass is sometimes easily disposed of into the storm sewers, but these sewers have their limitations, and a clogged sewer and a cleaning problem is up to the maintenance crew.

We have had trouble from a small sausage plant, which has operated in three different locations. At the first location the plant was connected to a short six inch lateral sewer with three or four other stores located at the edge of the central business district. No trouble resulted there, perhaps because the dilution was high enough to carry greases and soaps through to main sewers.

At the second location, the plant was connected to the end of a 285 foot long six inch lateral sewer, with no other service on the line. The six inch lateral was connected, at a manhole to a ten inch main line carrying a goodly

load of sewage from an area bordering the south side of the central business district.

The floors, tools and work tables of the plant were washed regularly with hot water and sal soda. The soapy substance thus created floated to the surface as the sewage cooled in the six inch lateral line, attached itself to the walls of the pipe line, crusted over the bottom of the manhole and gradually blocked the flow in the lateral line.

Patented grease traps were installed on request of the City to collect the grease, but failure to service the traps caused the same trouble to be repeated.

The proprietor volunteered to install an outside grease trap of a design furnished by Wm. T. Ingram, Sanitary Engineer, San Joaquin Local Health District, but decided to move to new quarters before it was installed.

At the third location, a double unit of the grease trap of the design furnished was constructed and connected to a sixteen inch main line sewer. No trouble has been reported after several years of operation.

We have the Stockton State Hospital served by the city's sewerage system. Some of the patients at this institution have a mania for disposing of sheets, pillow cases and cotton underwear into the plumbing fixtures. These rags pass through 3½ miles of sewers to reach the disposal plant, but strange as it may seem, they do not cause any noticeable trouble. The lines through which the sewage passes are 14″ or larger. The North Sewage Plant, which receives the sewage from the Hospital, collects two cubic feet of rags per million gallons, while the South Plant collects three tenths cubic feet of rags per million gallons.

On the other hand, a goodly percentage of stoppages of main sewers is caused by balls of lint, the cores of which have originated at laundries.

Cannery wastes are a problem from the cannery to the receiving waters for those communities having separate systems and treatment plants. The population equivalent of the Stockton cannery sewage wastes this month (Sept.) is 250,000 or four to five times as much as the actual population.

We have five canneries, four of which are located on the boundary line of the City, just out of the corporate limits. Most of the operators of these plants came to Stockton from a community having combined sewers and no treatment plant. Therefore, there was no regulation against free disposal of cannery wastes into the sewers.

Stockton has an ordinance which makes it a misdemeanor to discharge any fruit or vegetable waste into a sewer which will clog, obstruct or fill such sewer or interfere with the effective operation of any sewage disposal works.

These cannery operators, who have been accustomed to dumping all of their wastes into the sewer, violate the ordinance referred to. It is impossible to enforce its provisions because the canneries were invited to locate here by the Chamber of Commerce and they object to installing screens and disposing of their own wastes because it will increase the cost of their products and place them at a price disadvantage with competitors in nearby communities who do not have to keep their trade wastes out of the sewer.

It would seem that here is a problem that can only be solved by state-wide regulations.

An unusual problem was created when the city remodeled its sewage treatment plants several years ago. The fresh sludge is pumped from the north plant to the south plant through 10,000 feet of eight inch cement lined

cast iron pipe for digestion. This line passes under two branch channels of the San Joaquin River, and also over the adjoining levees, and over the Santa Fe railroad grade. There are along this line four summits in the pipe line grade. At the time of the design and construction of the line, the fact that these summits might be a source of trouble was overlooked.

The sludge pumps were three inch single stage, centrifugals, with two port enclosed propellers, capable of delivering 300 gallons per minute against a 32 foot maximum head.

When the plants were put into operation, the sludge was pumped twice daily to the conditioning tank at the south plant. As the capacity of the pipe line was equal to more than the volume of the daily sludge production, it remained in the line for a day. The gas produced by the sludge rising to the pipe line summits, formed a vapor lock similar to that experienced in oil and gasoline lines.

The sludge pipe line summits were vented by tapping in one inch outlets which were bled to relieve the vapor locks. However, these small vent lines would clog with sludge scum and have to be rodded to clear them. We thought for some time we would erect twelve inch or larger bleeder risers to height above the hydraulic grade line to relieve the trouble, but finally installed a high pressure six inch, two stage, centrifugal fire pump which was removed from an abandoned fire department pumper unit to replace one of the two small three inch centrifugals.

This pump capable of developing 100# pressure can force sludge through against any vapor lock and operates at 55# at 1800 r.p.m.

It is now used once a week to pump fresh sewage through the line to overcome the pocketing of gas and wash the line free from sludge accumulations.

Early this year a Reinsch-Whurl screen at our North Disposal Plant, after some 20 years of service, fell apart like the one horse shay. The structural members of the spider supporting the screen plates were reduced by corrosion to about 25% of the original dimensions and at some points were entirely gone.

The bronze plate screens were worn by the polishing abrasive action of the brushes so that separating strips between slots in many places were gone, and the plates were so thin they were bent by the scrubbing brushes.

The spider rebuilt of tee sections instead of double angles to provide less surface for corrosive action was reconstructed in the city corporation yard.

Everdur bronze plate, a special silicon bronze was purchased from the American Brass Company. This is a special alloy for sewage plant use. The slots were milled by a local machine shop. The cost of the new screens was about 95 cents per pound, or about 70 cents per square foot of screen. Brushes, gears and bearings were also renewed. The total cost of the job was approximately $1,200.

Sewerage system maintenance costs have varied in the last fifteen years from $34 per mile in 1934 to $86 per mile in 1928, and have stabilized at about $40 per mile for the last five years (not including catch basin cleaning).

The sewerage maintenance crew handles a tough job, subject to call at all hours, they work under severe and unsanitary conditions and carry on till the job is done—just another municipal service that is mighty handy when the Saturday Night bath water won't run out of the tub.

EARLY HISTORY OF CALIFORNIA SEWAGE WORKS ASSOCIATION

By C. G. GILLESPIE, Chief

And E. A. REINKE, Senior Sanitary Engineer

Bureau of Sanitary Engineering, State Department of Public Health

Looking backward to the beginning for a reason why people and things are as they are is nearly always entertaining and in the case of the California Sewage Works Association is inspiring. This Association assuredly has individuality. Each year it grows among the associations of public servants as one of the most earnest and intent groups that meets in this State. We wonder if our members prize that reputation and value what it is doing not only for the future standing of the Association among the officials who are our public, but also for what our example may be doing to raise the devotion of other public servants to their jobs and to the public interest.

In May of 1928 the State Department of Public Health sent an invitation to cities and others interested to consider the formation of a sewage works association. The call was sent out with no more hope than that the few who would come would not say "no" but would consent to think it over and be willing to meet again at a later date. So it was a surprise when all over the room men sprang up impatient to form an association at once. That early eagerness was important in the life of this Association.

Going back a little, in the history, individuals here and there about the State, in the early 20's, had been looking for knowledge to better handle their sewage problems and meet bothersome operating difficulties. In 1923 our Bureau sent out an informal invitation to a few interested officials to make a tour of several sewage plants in the Fresno area, following a meeting of the local American Water Works Association in that city. The attendance and the interest were fine, but for various reasons these meetings could not be kept up.

A few of us continued to be aware of the Sewage Works Managers Association in Great Britain, State Sewage Works Conferences in Ohio and Texas and of the satisfying research of the New Jersey Sewage Works Association and of Dr. Wm. Rudolfs in the New Jersey Agricultural Experiment Station, as well as important discoveries and undertakings by the Chicago Sanitary District and elsewhere throughout the country.

Against the background that must have prevailed over the country, an informal call was sent out by a small group of leaders in the east, among whom we recall were principally the late George W. Fuller, whom you know as a pioneer of sanitary engineering; Langdon Pearse, Sanitary Engineer of the Chicago Sanitary District; Dr. Wm. Rudolfs, various State sanitary engineers, and others. A conference was held in Chicago in June of 1927 at the national meeting of the American Water Works Association. At that meeting it was explained that an outlet was desired for the results of research, cost data and experience in the sewage works field, and a proposal was made that the various states, or in some cases regions, would form strong sewage works associations, separate from the American Water Works Asso-

ciation, each having its own government and local meetings, and publish what it wished. There would be a scheme of "federating" these associations, mainly to publish the cream of the local papers for nationwide distribution to the State groups. That plan of loosely-knit but strong State groups was an important decision. It was of course intended to overcome the difficulty and expense experienced in getting widespread attendance at national meetings, which it did, and it was felt it would make for vigorous local groups, as has been so well borne out.

As a result of this Chicago meeting a "Committee of 100" was selected from the various states, as well as Canada, to work up the idea. Representing California were Professor Charles G. Hyde, University of California; Harry B. Hommon, Sanitary Engineer, U. S. Public Health Service, San Francisco; W. T. Knowlton, Engineer of Sewers of Los Angeles; and C. G. Gillespie, Director of the State Bureau of Sanitary Engineering. The meeting in California June 11, 1928 was one of the earliest that came out of that Chicago gathering. It was held during the national convention of the American Water Works Association then meeting in San Francisco, but to avoid the possibility that it might look like intrusion on the water works convention, the meeting was held in the offices of the State Department of Public Health. Fifty-two men representative of all parts of the State, and various people interested in sewage disposal came to the meeting. There were also such noted guests as George W. Fuller, Abel Wolman, Chief Engineer of Maryland State Board of Health, and E. G. Eggert, Assistant Engineer of Texas State Board of Health. Both Maryland and Texas had somewhat similar organizations at the time. Each one gave words of encouragement and advice and told of achievements in this country and in Great Britain. Of the 52 who came, very few remain in the Association. Going down the list they are:—

H. B. Hommon, Fred W. Post, W. C. Roberts, J. F. Byxbee, Leon B. Reynolds, C. C. Kennedy, D. C. McMillan, J. L. McBride, Ralph Stevenson, A. M. Rawn, A. Segel, Chester A. Smith, W. T. Knowlton, R. F. Goudey, E. A. Reinke, C. G. Gillespie and H. F. Gray.

The complete list of those who registered attendance follows on pages 89 and 90.

Some have gone forever from the scene, among them Phil Schuyler, who did more than anyone else to start the Association. He was then editor of Western Construction News. We do not see how we could have done without him; his enthusiasm, his valuable paper, his contacts with the equipment firms and Western Construction News solved a publication problem which otherwise would have plagued us for years. It was fortunate for the Association that early in his career Phil Schuyler had been exposed to a sewer job and it must have infected him for life, for right to the end this Association was his hobby. He was a great peacemaker in a day when dis-unity might easily have fastened itself on a young association. Both traits were important for its future. Now you begin to see what we mean about the spirit of the pioneers explaining why things are as they are. Phil Schuyler was only one of many such pioneers in this Association.

The result of this meeting in San Francisco in 1928 was a definition of purpose of the new Association, which contained among its objects, "the friendly exchange of information." If one word had to size up this Associa-

tion it is the word "friendly." The meeting elected an organizing committee composed of A. K. Warren, General Manager of Los Angeles County Sanitation Districts, now deceased; A. M. Jensen of Fresno, who later lost his life in a sewer gas tragedy; O. E. Steward of Santa Ana, Phil Schuyler, both now deceased, and the writer. The group also voted to request membership of the Association in the federation, and fixed dues at $2.00 per year, with no admission charge. A. K. Warren was elected chairman of the organizing committee and working committees were forthwith appointed as follows:

Constitution and By-Laws, and Nominating Committee:

W. G. Knox, Santa Ana
A. M. Rawn, Los Angeles
Leon B. Reynolds, Stanford University
Fred Post, Lodi
C. C. Kennedy, San Francisco, Chairman

Membership Committee:

All the members with W. T. Knowlton, Los Angeles, Chairman

Program Committee:

Alva J. Smith, Los Angeles
W. C. Earle, Pasadena
J. J. Jessup, Los Angeles
Harold Young, Los Angeles County
R. F. Goudey, Resident Engineer, State Department of Public Health, Los Angeles, as Chairman

Before adjournment the meeting voted to hold its first annual convention in San Bernardino October 9-12, 1928, in conjunction with the League of California Municipalities. By the time of the San Bernardino convention the Association had 117 charter members, of whom 30 were among the original 52 who came to the organization meeting in San Francisco in June of that year, 44 represented engineers in City, County, or State employment, 19 were administrators such as chairmen of sewer committees or inspectors, 18 were consulting engineers, 17 were engaged in commercial enterprises, 11 were operators and sewer superintendents, 4 were more interested in laboratory and research, and 4 were unclassified.

The serious-mindedness of the members who attended the San Bernardino meeting was indeed a good omen, and it has lasted through the years. It has made us particularly studious and inclined to face facts squarely and to try and interpret observations accurately. It has kept us hewing to the line, which in our case is a big part of a mighty good purpose of giving our people a better degree of sanitation.

The names of those early founders of the Association show you the source of wise judgment that gave the Association its start. Teamwork came natural among them and we are happy to think that selfishness still prevails in unusual degree in this group. That, too, is important. Too many professional groups slip into personal secretiveness and petty jealousies. Soon the habit becomes a disease.

Among the organizers of the Association it was natural that there were many men whose interests lay in commercial lines. It would have been easy

for them to have sought to dominate the Association for their own ends. Therefore it is outstandingly to their credit that their whole attitude was likewise unselfish, helping from the sidelines. You will note that they do not appear among the early officers. Through the contribution they made and the advertisements of their firms in the journal it was possible from the very beginning to have a local publication, which of course soon gave the State an understanding of the purposes and value of the Association.

The drawing of a constitution and by-laws is more important than may appear from day to day. In this case the principle of succession for officers met ready response. It takes two years to reach the presidency and of five Directors only one is replaced each year. Thus we have no sudden "New Deals."

Leading off with Professor Leon B. Reynolds of Stanford University, far-sighted men have always been chosen for officers right from the outset. F. A. Batty, Engineer of Sewer Maintenance in Los Angeles, was first vice-president; B. J. Pardee, now City Manager of Monterey, was second vice-president; and E. A. Reinke, Assistant Engineer in the State Department of Public Health, was the first secretary and treasurer. The first directors were F. M. Lockwood, City Manager of San Diego, the late A. W. Wyman, Superintendent of the Pasadena Sewage Treatment Plant, the late Phil Schuyler, the late A. K. Warren, General Manager of the Los Angeles County Sanitation Districts, and the writer. Representatives on the Board of Control of the Federation were C. C. Kennedy, Consulting Engineer of San Francisco, and W. T. Knowlton, Engineer of Sewers in Los Angeles.

From the beginning the policy was adopted of trying to keep a balance in representation between the north and the south and between the different interests that composed the membership. That is extremely important. Otherwise you soon find the "ins" and the "outs." In the matter of program the officers were solicitous of the varied avenues of activity represented by the membership and programs were designed to appeal as broadly as possible. The San Bernardino program undoubtedly set a good pattern and was well received. It covered a wide range of topics in design, construction, operation, research, manufacture, and financing of sewer systems, and of various types of sewage treatment, pumping stations, and minor devices. There was even a little laboratory demonstration.

The matter of meeting places was a source of much debate in the early years. In the case of the San Bernardino meeting there was more or less interference in programs between the League of California Municipalities and the Association. A sizable group felt that the lustiness of the Association was such that we should meet by ourselves. In other words they were for isolation. The majority, however, were for a middle course and at the time it was thought that the Association should be sufficiently independent that it could hold meetings, at times by itself and on other occasions with the League of California Municipalities, the American Water Works Association, the American Public Health Association, or the American Society of Civil Engineers, depending on circumstances. The principal tie, however, has always been with the League of California Municipalities. The League has always been glad to have us meet with them and we have been glad to meet with them. The Association has nearly always contributed at least to one session with the engineers and councilmen.

The enthusiasm for more frequent meetings and the realization that meetings staggered between the north and the south meant long intervals in which a given region had no meeting at all, led at once to the idea of a spring meeting to which the term "Conference" was applied to distinguish it from the big annual meetings. These spring conferences have offered play for the enthusiasm and independent spirit of this Association and they are undoubtedly now a fixture with us.

Thus along the way there seem to have been so many wise and fortuitous decisions and a readiness to compromise that have stamped indelibly a fine individuality of its own on this Association.

And may we close this early "history" by again reminding you of the objects of the California Sewage Works Association, cited in the call to form this Association: "The advancement of the knowledge of design, construction, operation, and management of sewage works, *and the friendly exchange of information* and experience therein."

To bring the history up to date:

Twelve annual meetings and twelve spring conferences have been held by the California Sewage Works Association. Field trips have been taken in connection with the sessions covering most of the State from Chico to the Mexican border. Nineteen Journals, including 225 papers and the proceedings of the meetings and conferences have been published by the California Sewage Works Association during a twelve year period and sent to all members. Many of the papers presented at the California meetings have been published in the Federation Sewage Works Journal which is also distributed to all members of the Association. Thus each member has had an opportunity to review the papers and proceedings even if he could not attend the sessions. Naturally, those who have attended and taken part in discussions, both formal and informal, have benefited most.

Papers have been presented by 150 persons (mostly members) on 225 topics including 23 on Sewers, 7 on Trade Wastes, 25 on Finances, 28 on Laboratory or Research Problems, 45 on Disposal and Disposal Methods, 10 on Odor Control, 65 on Operation and Maintenance of Plants, 37 on Plant Descriptions and 23 on Miscellaneous Subjects. In addition to the technical program it has been the custom of the Association, since the idea was first presented by A. M. Rawn in 1935, to have an address by a guest speaker following the banquet at each meeting or conference. This practice has helped to broaden the interest of the members as well as to increase outside interest in our Association.

A. K. Warren served as Chairman of the organizing committee and presided at the first annual meeting. Twelve members have served as President. Three have served as Secretary-Treasurer. Two Vice-presidents complete the roll of officers. It has been the custom to elect a vice-president to serve two years before advancement to the presidency. Sixteen members have served as directors for five-year periods and eleven as representatives on the Board of Control of the Federation of Sewage Works Associations. One hundred and four members have served on one or more of the regular committees of the Association. Many more have served on special committees, particularly those in charge of local arrangements at each session. Members have given of their time unstintingly, to serve as officers, committee members or speakers.

Members of the Association have worked actively with the School of

Public Administration at the University of Southern California on short courses in connection with sewage works problems, and since 1932 a committee on licensing operators has been actively at work. Since 1935, largely through the efforts of R. F. Goudey, this committee has been working in cooperation with a similar committee of the California Section—American Water Works Association under one chairman and the name has been changed to "Committee on Certification of and Schools for Sewage Works Operators." This committee has stimulated interest of operators and they are now taking a more active part in the program than was the case in the early years.

Beginning in 1935, Western City magazine reserved a page in each issue for use of the California Sewage Works Association. The magazine is the official publication of the League of California Cities and is sent to all city officials in the State. The publicity has been of inestimable value to the Association. Here again A. M. Rawn enters the picture as editor of the page.

The California Association has attracted many speakers from the East and Middle West. In the early days members were attracted from other western states. The Arizona Association has met with our group and several California members have attended and participated in meetings in Arizona. Five residents of foreign countries are now members of the Association. Ten are residents of other States and one lives in Hawaii.

Professor Charles Gilman Hyde, who represents our Association, and has also served a term as Member-at-large, on the Federation Board of Control, wrote the Introduction to "Modern Sewage Disposal," the Anniversary Book of the Federation of Sewage Works Associations. Messrs. A. K. Warren and A. M. Rawn wrote the chapter on Disposal of Sewage into the Pacific Ocean. Among our members who have attended meetings of the New York State Association which holds a joint meeting with the Sanitary Engineering Section, A.S.C.E., at the time of the annual Federation meeting, are our first president Prof. Leon B. Reynolds, C. C. Kennedy, C. G. Gillespie, Alexander Bell, H. F. Gray, Prof. Charles Gilman Hyde, A. K. Warren, A. C. Beyer and R. R. Ribal.

Of the 122 members listed in the 1928 Journal, 44 are included in the roster as of July, 1940. These have served as a nucleus throughout the years. Membership increased rapidly from 115 at the 1928 meeting to 237 in 1931, dropping a little through the depression years to a low of 185 in 1935 and rising again to an all-time high of 266 in 1940.

One may conclude from these random notes that the Association has, through a variety of activities by individual members and by committees, followed out the objects of its founders and served as a "clearing house" for ideas on many subjects related to sewage collection, treatment and disposal. It will undoubtedly continue this work for many years to come. The field of endeavor is constantly expanding with new problems and methods appearing from time to time. Industrial wastes were a problem when the Association was formed, and have been discussed at nearly every meeting, but progress in treatment and disposal has lagged far behind that for domestic sewage. Industrial wastes are still a problem.

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC HEALTH

SACRAMENTO

Division of Sanitation
Bureau of Sanitary Engineering
C. G. Gillespie, Chief
May 2, 1928.

SUBJECT: SEWAGE WORKS OPERATORS' ASSOCIATION

City Clerk, Board of Trustees, or City Council:

This is an invitation to your officials to send your sewage works superintendent or any officials interested to attend a meeting at the State Building, Civic Center, San Francisco, at 9 A.M., June 11, 1928, to consider organizing a California Sewage Works Association, being a part of a national federation of state units concerned with this municipal problem.

That proper arrangement may be made for the organization meeting and to indicate prospective strength of the membership, will you please reply as early as possible, giving:—

(a) The names or number of representatives your city expects to send to the meeting.

(b) The names or probable number of your officials or employees who may become members, though not attending the organization meeting.

As the task of a separate address to each of the interested officials of the state is great, a number of copies of this invitation are enclosed with the hope that you will place them in the hands of your trustees, city engineer, sewage works superintendent, etc.

This Association is for the common interchange of experience in sewage treatment, disposal, research, sewer maintenance and pumping. It has for a successful precedent the American Water Works Association, in the California section of which practically every city is represented.

The National Federation will issue its first quarterly journal July 1, 1928. Our members will also secure this journal. The tentative dues for the journal are $1.00 or $2.00.

The remainder of the week is to be consumed by the convention of the American Water Works Association which meets in San Francisco this year. That Association will welcome your representatives to remain for its sessions.

Anticipating your keen interest, I am,

Yours very truly,
BUREAU OF SANITARY ENGINEERING,
By C. G. Gillespie, Chief.

San Francisco, Calif.
June 11, 1928.

Resolution No. 1

RESOLVED that there be formed in the State of California an organization to be known as the California Sewage Works Association whose objects shall be the advancement of the knowledge of design, construction, operation and management of sewage works and the friendly exchange of information and experience therein.

Name *Title* *City*

George W. Fuller, Cons. Engr., New York
R. M. Berryhill, City Engr., Tulare, Cal.
T. C. Hampson, Mayor, Tulare, Calif.
H. B. Hommon, San Francisco
F. R. Shaw, Sanitary Engineer, San Francisco

H. D. Cashmore, Asst. San. Engr., San Francisco
D. E. Perry, Mgr., Sanitary Dist. No. 1, Marin Co., San Anselmo
H. J. Flannery, Asst. City Engineer, San Jose, Calif.
E. A. Ingham, Sanitary Engr., San Francisco
Clyde L. Jenken, City Engr., Santa Ana
J. F. Blakely, City Clerk, Lodi
Fred W. Post, Mgr., Sewage Disposal Plant, Lodi
W. C. Roberts, Pac. Engineering Laboratory, San Francisco
L. H. Biggar, Research Engr., Pasadena, Calif.
B. J. Pardee, City Mgr., Visalia
J. F. Byxbee, City Engineer, Palo Alto
Andrew M. Jensen, Commissioner of Public Works, Fresno
Leon B. Reynolds, Board of Public Works, Palo Alto
Clyde C. Kennedy, Consulting Engr., San Francisco
E. E. Simmons, Clerk Sanitary Board, Saratoga, Calif.
M. Caine, Engr. Sanitary Board, Saratoga, Calif.
Fred D. Buskirk, Sanitarian, San Diego County
Ed. W. Beale, Chief of Division, Plumbing, Housing & Sanitation, San Diego
A. H. Tonyer, Pres., Rodeo Sanitary Board, Rodeo, Calif.
James Brown, Water Supt., Turlock
D. C. McMillan, City Engineer, Ventura
A. W. Wyman, Plant Supt., Pasadena
J. L. McBride (Ch. Exec. Com.) Orange Co. Joint Outfall
L. G. Williams, Sanitary Engr., Long Beach
A. M. Rawn, Asst. Chief Engr., L. A. Co. San. Dists.
A. Segel, Engr. Private Practice, Fresno
M. A. Robinson, Supt. Water Dept., Ventura, Cal.
Ralph A. Stevenson, Supt. Filtration, Sacramento
Wellington Donaldson, Fuller & McClintock, Engrs., New York City
T. E. Cunnane, Chairman Sewer Com., Ventura
E. G. Eggert, Sanitary Engineer, State Dept. of Health, Austin, Texas
Chester A. Smith, Consulting Engr., Los Angeles
W. T. Knowlton, Sanitary Engr., Los Angeles
W. B. Hogan, City Engineer, Stockton
R. F. Goudey, St. Dept. Public Health, L. A.
A. T. Hastings, 714 Central Bldg., Los Angeles
C. E. Wood, Engineer, San Leandro, Cal.
Philip Schuyler, Editor W.C.N., San Francisco
Ned D. Baker, Civil Engr., Oakland
T. B. Lewis, Member, Rodeo Sanitary Board
Abel Wolman, Baltimore, Md.
E. A. Reinke, St. Dept. Pub. Health, Berkeley
C. G. Gillespie, Ch. Eng., State Bd. of Health, Berkeley
A. H. Pape, Marin County
R. Burgess, Gilroy
E. L. Wright, Supt. of Sewer Farm, Orland

SOME LEGAL ASPECTS OF SEWER AND STORM DRAIN MAINTENANCE

By HUGH McDONALD

A number of years ago a water commissioner of a large city published an admonition to the citizens of his town in these words:

> "I desire that nobody shall conduct away excess water without having received my permission or that of my representatives, for it is necessary that a part of the supply flowing from the water castles shall be utilized not only for cleansing our city but also for flushing the sewers."

The name of the commissioner was Frontinus,—the city was imperial Rome, and the time was the First Century, A. D. And although it is probable that the science of municipal sanitation was hardly as important an element in the city government of that early period as in our day, it is apparent from the commissioner's remarks that even then those engaged in ridding the cities of refuse had their problems.

Before the commissioner's time, ancient peoples moved their villages when their accumulations of refuse grew too offensive to be bearable; modern cities must now move the refuse, and so there has arisen the sewage engineer to inherit all of the difficulties of his Roman progenitor plus many more which are supplied by his city's required observation of the rights of private property owners, the suppression of floods and odor nuisances, and similar aspects of his day's work.

It is the purpose of this paper to notice briefly the legal side of a few of the sewage engineer's relationships with the citizens and property owners of his community in the operation and maintenance of its sewers and storm drains, particularly with respect to negligence under the present California statutes. For this purpose we may consider for a moment some of the legal aspects of a problem typical of those with which the sewage engineer is all too familiar:

Following an extremely severe rainstorm, the engineer in charge of sewers and storm drains of a California city is called upon by Citizens Smith and Jones. When Citizen Smith is able to bring his voice under control, he informs the engineer in most emphatic language that the basement of his house is flooded from the backing up of a sanitary sewer connection; that sewage and storm water have utterly ruined a number of trunks and boxes full of art objects and very valuable tapestries, and that he is instructing his attorney to file action against the city immediately. Citizen Jones now interrupts with the comforting news that most of his new lawn and garden is three feet under water because the new municipal storm drain is entirely too small to carry off the amount of water that should be handled, that he is advised that the water will not recede for two weeks, that the damage is estimated at $3,000, and that he proposes to accompany Smith to his attorney's office with the same purpose in mind.

Having finally bowed Citizens Smith and Jones out of his office with all the diplomacy he can summon, and commendable control of his own temper, the engineer does a bit of speedy and earnest thinking, then hurriedly dispatches a crew to the vicinity of Citizen Smith's home to trace the trouble. Four hours later his worst fears are confirmed—the crew foreman reports that he has found and removed from the lateral sewer opposite Smith's property a large tree root that partially plugged the pipe for a distance of 15 feet, and that Smith and a number of his neighbors observed the operation from the sidewalk with various caustic remarks about the maintenance and repair service and the shortcomings of the incumbent city administration. The City Engineer promptly confers at length with the City Attorney.

It is apparent to the City Attorney that the question of Smith's damage may involve two distinct liabilities: First, that of the City itself; and, second, that of its individual officers.

His first concern is for the City. Accordingly, he, and ourselves likewise, may save the question of individual liability for another discussion.

He informs the Engineer that the liability of the City for injury to persons and property resulting from dangerous and defective conditions of municipal works is measured by the Public Liability Act of 1923 (Stats. 1923, p. 675; Deering's Gen. Laws, 5619). He reads Section 2 of this Act, as follows:

> "Counties, municipalities and school districts shall be liable for injuries to persons and property resulting from the dangerous or defective condition of public streets, highways, buildings, grounds, works or property in all cases where the governing or managing board of such county, municipality, school district, or other board, officer or person having authority to remedy such condition had knowledge or notice of the defective or dangerous condition of any such street, highway, building, grounds, works or property, and failed or neglected for a reasonable time after acquiring such knowledge or receiving such notice to remedy such condition, or failed and neglected for a reasonable time after acquiring such knowledge or receiving such notice to take such action as may be reasonably necessary to protect the public against such dangerous or defective condition."

The Attorney instantly observes that the question of Smith's damage is not concerned with any measures to warn or protect the public since the character of the sanitary sewer makes the matter of barricades or warning signs meaningless and inapplicable. He likewise perceives that to render the municipality liable for the damage Smith will have to prove three elements, and these he discusses fully with the Engineer:

First: Does the presence of the root in the lateral create a dangerous and defective condition?

The Engineer replies that the answer to this should be easy. The root certainly obstructed the flow through the pipe, the flow backed up, the backed-up sewage ruined Smith's property; wherefore, the dangerous and defective condition is obviously created.

The Attorney, however, mindful of the extraordinary volume of the recent rain, asks many questions:

Has there been any indication of trouble with the sewage flow at that point prior to the rain? Had the City ever experienced a storm as great as this one? In the Engineer's opinion what proportion of the normal flow through the pipe was obstructed? Would the pipe have handled the normal peak load in heavy rains without backing it up, despite the presence of the root?

The decisions announce the rule that where the storm or flood is so great that it could not reasonably have been anticipated, there could reasonably have been no provision made against it, and, accordingly, there will be no municipal liability from consequent flooding, "nor in such event would there be liability for damage done by reason of the condition created by the storm."

A recent case from an eastern jurisdiction (*Bennington v. Fillmore and Slade,* 130 Atl. 137) states the rule in the following language:

> "When the damages suffered are proximately due directly and exclusively to natural causes without human intervention, which could not have been prevented by any amount of foresight, pains and care reasonably to be expected, there is no liability because it is an Act of God. But, if the damages were not due exclusively to such natural causes, in other words, if the negligence of the one sought to be charged mingles with the operation of the natural causes, the injury is not, in a legal sense, the Act of God."

In *Newman v. City of Alhambra* (179 Cal. 42, 175 Pac. 414), the Court held that "If it appears that a given loss has happened in any way through the

intervention of man, it cannot be held to have been the Act of God but must be regarded as the act of man."

In an early California case (*Spangler v. City and County of San Francisco,* 84 Cal. 12) damage was alleged to have occurred to private property after a storm and flood of extraordinary size. The City raised the defense that the storm was of unforeseen magnitude and denied liability. But, from the evidence taken in the case, the Court found that the drain in question was clogged and full of obstructions, and further found that had it been maintained in a proper condition it would have been sufficient in size to take care of the flood water even though the storm was greater than any that had been known. The Court properly concluded that the damage was due, not entirely to the unforeseen volume of the storm, nor to any inadequacy in the size of the drain, but to the clogging and obstructions, and held the City liable for its palpable negligence.

So, even if the storm is unprecedented in magnitude there may still be liability if municipal negligence combined with it to produce the damage. But the question naturally occurs: How much must the negligence contribute—how substantial must it be? There is to the writer's knowledge in California decision to assist us, but a most unenlightening case that was tried in Pennsylvania many years ago lays down a principle that should doubtless be adopted in any similar controversy litigated in this state.

Plaintiff in this case contended that three culverts put in and maintained by the defendant were negligently maintained, and that as a result of the concurrence of such negligence with the force of a great storm, the damage occurred and the defendant accordingly should be liable. The court made the following observations in the course of an opinion declaring the decision of the trial court to be erroneous:

> " * * * the (trial) court ruled that: 'If there was negligence on the part of the defendant concurring with the act of God at the time plaintiff's loss was sustained, then the defendant is liable, and the jury are not bound to inquire whether the loss would have happened, if the defendant had not been guilty of negligence? As we understand this point, it practically declares that although the act of God alone, without any negligence of the defendant would have caused the injury, the jury were not at liberty to consider that fact, if in reality there was negligence on the part of the defendant concurring with the act of God. In other words, no matter how terrible, extraordinary and unprecedented were the storm and flood, so that they alone caused the injury, yet if there was a concurring negligence of the defendant, although it did not produce the injury, and its absence would not have prevented it, still the defendant would be liable. * * * Now a small pebble in one of the culverts would in some small degree impede the course of the water, yet the doctrine of this point * * * would make the defendant liable for the entire injury, even though a huge avalanche of water were suddenly launched upon the stream and hurled with irresistible force upon the embankment and culverts in question. Such is not the law. * * * We apprehend that the concurring negligence, which, when combined with the act of God, produces the injury, must be such as is in itself a real producing cause of the injury, and not a merely fanciful or speculative or microscopic negligence which may not have been in the least degree the cause of the injury. In other words: If the act of God in this particular case was of such an overwhelming and destructive character, as by its own force, and independently of the particular negligence alleged or shown, produced the injury, there would be no liability though there were some negligence in the maintenance of the particular structure. To create liability it must have required the combined effect of the act

> of God and the concurring negligence to produce the injury. The present case affords a fair illustration of the reason for this distinction. The defendant's witnesses testified that the force and volume of the water were so very great that it would have required one hundred and twenty such culverts to pass it off. Hence, if the three culverts were in the most perfect condition, they would not at all have prevented the injury, and therefore the fact that they were somewhat obstructed might be quite immaterial. * * * For these reasons we sustained the * * * assignments of error."

These are substantially the tests by which the Attorney will determine whether or not the City may avail itself to the defense of the act of God.

The Engineer now informs the Attorney that the City has had three storms of equal or greater severity in the past fifteen years. The Attorney promptly concludes that the defense of "Act of God" or unprecedented flood is not available to the City, since experience has demonstrated the possibility of occurrence at any time of a storm of this size.

The discussion now passes to the next element:

Did the authorized Board or officers of the City have any knowledge or notice of the presence of the root in the lateral?

The Engineer promptly replies, "Of course not. We knew nothing about it and if we did we would certainly have pulled it out immediately."

This answer by no means satisfies the Attorney. By it he is assured that no one on the engineering staff or in the city administration had any direct knowledge of the condition; he can likewise be certain that no passerby either could or did discover its presence from anything that might be seen on the surface of the ground. But this isn't enough.

His next question, which, because of the concealment of the facilities underground, is the all-important one to the sewage and storm drain engineer, is as follows:

Should you have known or suspected the presence of the root?

This may well be the turning point in the City's defense upon the trial of the case. Stated in another way, although there may have been no actual notice, was there constructive notice—did the authorities and personnel of the City, charged with the duty of maintenance and repair, perform that duty appropriately, and did such performance disclose circumstances from which the presence of the root should reasonably have been suspected and, therefore, discovered?

If under similar surrounding conditions it be found that maintenance personnel, possessed of ordinary skill and ability, would have discovered the root in the proper discharge of their functions, the City may be charged with constructive notice of its presence, and consequently liable for failure to comply with the rule arising from the third element, namely, to repair or remedy the condition within a reasonable time after such notice.

The third element, just mentioned, causes the Attorney no difficulty, since he agrees with the Engineer that the trouble would have been speedily cured had anyone suspected and discovered its existence. Therefore, the only remaining point of difficulty is to establish as definitely as possible the duty of the maintenance personnel under the particular circumstances.

Turning to the cases, the Attorney finds an excellent expression of such duty in the following words of an eastern judge, which, while not interpreting the California statutes, are nevertheless most appropriate:

> "Ordinarily, and in the nature of things, only the officers and agents of

> the municipality could know of such obstruction as that of which complaint is made, and there could be no passerby who could give the information. The location of the obstruction was open only to the employees of the municipality and it was their duty to inspect it from time to time and ascertain the fact that no obstruction existed. Only by such inspection was it possible to ascertain the existence of such obstruction. If that work of inspection was neglected by the municipality, it has no right to say that it must have notice from some other source, and its neglect of duty cannot be made the basis of exemption from liability." (*District of Columbia v. Gray,* 6 App. D. C. 314.)

Likewise, in a California case, (*Kramer v. City of Los Angeles,* 147 Cal. 668, 82 Pac. 334), decided prior to the adoption of the Public Liability Act, the Court had before it a somewhat similar situation, and applying this rule, held "that it is the duty of a city to anticipate the probability of such occurrences and to guard against them by occasional examinations and cleansings."

Thus, according to the principle of these and other decisions, if known causes are likely to produce dangerous and defective conditions, there is a duty to inspect for these conditions—if it can be reasonably anticipated that erosion or wear in any particular locality may produce such conditions, there is a duty to anticipate them, and where it is reasonably probable that tree roots such as the one under discussion may cause trouble, the City and its maintenance personnel must be on their guard.

The final question, namely, whether or not this duty to inspect was properly discharged by the Engineer and his maintenance staff without discovering the root, or whether its location and size were such that it could not reasonably have been discovered in the performance of that duty, — is one that, regardless of its importance to the City Attorney, need not concern us here. There are many, many Smith cases, each of which must be determined on its own facts and under its own particular circumstances. In some the municipal liability or freedom from liability may be seen at a glance; in others the question may keep a trial court long perplexed or a trial jury out for days. But our City Attorney, as he carefully reviews the Engineer's history of whatever inspection and maintenance preceded the storm, and likewise the court on the trial of the case may well weigh the performance of the City's maintenance personnel with these words of the Supreme Court of Connecticut:

> "The test is not, would the defect have been discovered had the particular portion of the street in question been examined, but would it have been discovered if the municipality had exercised reasonable supervision over its streets as a whole; it is not, did the City use all means at its command or available to it for the discovery of defective conditions, but did it exercise a reasonable supervision in view of the whole problem of which it was confronted?" (*Ritter v. City of Shelton,* 135 Atl. 535, 537.)

This principle was adopted and approved in a very recent California decision (*Nicholson v. City of Los Angeles,* 5 Cal. (2d) 361), and is thus the law in this state.

Our City Attorney now directs his attention to possible municipal liability for the flooding of the Jones lawn and garden. In discussing the matter with the Engineer, he learns that Jones has a large and very elaborate home and extensive grounds which have only recently been landscaped and developed with trees and shrubs. The place is in the bottom of a shallow canyon, with low rolling hills on either side. It appears further that the storm drain has been put in a short time before, in order to get rid of the waters that accumulate in the canyon during storms.

As recounted by the Engineer, Jones appears to be complaining about two things: First, that the City knew very well the approximate amount of water to be expected during the rains and should have provided accordingly, but that the drain was badly designed and failed to get rid of all the water; and, second, that the drain was constructed and maintained in such a manner that it had not only failed to drain the waters, but diverted a large portion of them over onto the Jones property.

The Attorney promptly sets the Engineer's mind at rest respecting the first ground of complaint. The municipality is not bound to supply drainage and, therefore, not liable for furnishing incomplete drainage. When and where, and how large, or how small to build its drains are matters which involve municipal discretion, and the courts will generally refrain from trying to substitute their own judgments for those of the properly qualified persons who are charged with the duty of making these decisions. The United States Supreme Court held in an early case before it (*Johnson v. District of Columbia,* 118 U. S. 19, 30 L. Ed. 75), that the duties of city authorities in adopting a general plan of drainage and in determining when, where and what size sewers were to be built, involved the exercise of deliberate judgment and were not subject to revision by the courts in a private action for not sufficiently draining particular lands.

In the words of a Pennsylvania decision (*Schroeder v. Borough of Mechanicsburg,* 74 Pa. Super. 532):

> "The mere fact that injury resulted after the improvement was completed raises no presumption of negligence. It may be admitted that the result shows that the improvement was not planned according to the best engineering skill else there would have been no collection of water on the property; but the adoption of a particular scheme of improvement was with the Borough Council and it cannot be held for lack of skill for not selecting the very best plan. It might be called upon to answer for negligence in the actual work of construction or for failure to keep the work in repair after it was completed, but not for lack of judgment in the selection of a plan."

And an early Kansas case (*City of Atchison v. Challis,* 9 Kans. 410), announces the principle this way:

> "Whether a city will construct drains of any kind and where it will construct them are purely discretionary. This principle is so well settled that it is not necessary to cite authorities in support of it. * * Now, if a city is not bound to construct a drain of any kind, by what system of reasoning can it be made to appear that if it shall construct a drain it must construct one that shall be sufficient in all cases and for every emergency? Any drain is better than no drain. Any drain, instead of being an injury to a party, is, so far as it operates, a positive benefit. If it carries off half the water that falls upon his premises instead of the whole, how can that be said to be an injury? Is it not an actual benefit to the extent that it operates? And if a benefit, upon what principle can the city be made liable? A city, in exercising its discretionary or quasi-judicial powers, acts not merely for a private individual or individuals, but for the general welfare of all its citizens. And in constructing drains it may construct them so as to drain the streets or alleys only or so as to drain the property of its citizens; and in draining the property of its citizens the drains may be so constructed as to carry off all the water that may fall or accumulate on the premises of an individual or only a portion thereof; and they may be so constructed as to carry off all the water that may fall or accumulate on the premises of one person and only a portion of what may fall or accumulate on the premises of some other persons. We think it is true that if a city constructs a drain every individual interested in the drain has a right to rely upon the drain operating to the extent of its

> capacity * * * but we know of no principle that would give any party a right to demand or expect that the drain should operate to an extent beyond its capacity."

The second contention of Citizen Jones causes the Attorney a great deal more concern, and he questions the Engineer carefully. Was there a well defined water course running through the canyon prior to the construction of the drain? Was there a dam or embankment or retaining wall of any sort built in connection with the drain, and, if so, where? And if there was a previous channel, is the drain so small or was it maintained in such a manner that the amount of water that it could handle was less than the quantity which normally was handled by that channel?

For now the question of sufficient capacity may present itself in quite another way. That very lack of size or capacity must not result in damage to property by any backing up or impounding of the waters which would naturally flow and escape had the drain not been built. If this be the situation, municipal liability might readily be created. If the City creates the necessity for the drainage it must provide entirely adequate facilities to accomplish that drainage. Accordingly, what the Attorney is attempting to determine is whether the quantity capable of being handled by the new drain is equal to or less than the quantity formerly conducted away in the natural channel if there was one, or by the natural slope of the ground if there was not. If it be less than such amount it is obvious that adjoining property owners may be in greater danger of floods than before the drain was constructed. If it be equal to or greater than that amount, they are at least no worse off than before and accordingly may not complain. And where there has been no natural drainage at all there is, of course, no municipal liability, since as has been observed, "Any drain is better than none."

It must be remembered, however, that the rule that "Any drain is better than none" does not allow a municipality in providing such a drain to divert flow onto property which has never received such flow. In other words, they are entitled to all of the advantages they enjoyed by the natural drainage, and if the new drain causes damage by restricting such advantages, they may have a right of recovery.

A concise discussion of these principles appears in a California case (*Shaw v. Town of Sebastopol,* 159 Cal. 623; 115 Pac. 213), in which plaintiff attempted to enjoin the improving of a street with macadam pavements and culverts. She contended that the completion of this improvement would cause a large amount of surface waters to be collected and thrown upon her lands. The rule therein laid down by the court is that a municipal corporation has no more right than an individual to collect surface waters and precipitate them upon private premises to the injury of the owner; that if the effect of improving the street was to alter the natural conditions and discharge upon plaintiff's land a large volume of water then would naturally have flowed there, liability would be established. In this case, however, the evidence failed to sustain plaintiff's contention when the court found that the improvements would divert no more water than before on her land and thus her attempt to secure an injunction failed.

Thus concludes the first discussion between the City Engineer and the City Attorney on the Smith and Jones cases. There will be others before the cases are called for trial, and both Engineer and Attorney will spend many

hours in the preparation of detailed and comprehensive evidence for the City's defense, and legal authorities to assist the trial court in the interpretation of that evidence.

Only basic and general principles have been touched upon in this conference. Greater legal detail will be the special province of the attorney, just as greater technical drainage detail will be that of the engineer. But since they must and should work as a team, not only in the preparation of their municipal lawsuits, but in their municipal preparations to avoid law suits, it is well that each have some understanding of the field occupied by the other. And to that end these remarks are respectfully dedicated.

NOTES

From the Secretary's File

Those of you who had the pleasure of being greeted with a cheerful "Hello, What can I do for you" at the Registration Desk in San Diego will remember the fine work done by Mr. M. A. Bent and his daughters, Avis Ann and Vera Jo. They registered 107.

Out of State Guests at San Diego included R. E. Stallings and L. H. McIntire, Tucson, Arizona, A. J. Fischer, New York, N. Y., and F. C. Roberts, Jr., Phoenix, Arizona.

Of decided help to the conduct of the meetings was Mr. Philo O. Knapp, whom you may have noticed getting secretarial notes with remarkable accuracy and speed. We are indebted to B. D. Phelps for allowing him to spend the time at the meetings.

Bernard Rowntree, operator at Carmel, spent some time preparing sage advice to his townspeople. This was printed in the Carmel Cymbal, September 6, 1940:

To The TAX PAYERS of the CARMEL SANITARY DISTRICT

Your new Sewage Treatment Works has been in Service since September, 1939. It is working very well. YOU CAN HELP to make it work better.

HOUSEWIVES

Use your Disposal or garbage can for garbage. Throw your old dish rags, toothbrushes and large pieces of food into your garbage can. DO NOT use your toilet for a garbage can.

SERVICE STATIONS

Clean out your sand and grease sump (trap) as often as necessary to keep oil and sand from going into the sewer. Oil and grease and sand will NOT digest (turn into fertilizer). Mineral oils kill the bacteria that digest the animal and vegetable matter.

HOTELS & RESTAURANTS

Clean out your grease traps as often as necessary to keep the grease from going into the sewer. DO NOT allow rags or large pieces of food to pass into the sewer.

CITIZENS

This is your property. You paid for it. You pay for its operation and care. You can make it more useful.

John F. Skinner advises that he has extra copies of the SEWAGE WORKS JOURNAL as follows:

Volume III, 1931, No. 2, 3
Volume IV, 1932, No. 2
Volume VI, 1934, No. 2, 3, 6
Volume VII, 1935, No. 1, 2

If you need one of these please make your arrangements direct with Mr. Skinner.

New members in 1940 since July are as follows:

Walter Silberbauer
California Packing Corporation
A. W. Gruss
Gilbert A. Dunstan
Don Reinoehl
Leo W. Ruth
George Mattimoe
W. S. Everts
Morgan Stewart
E. W. Fraters
Charles Conger
Fred J. Early
Julian Bardoff
M. J. Shelton

New members applying in 1941 include:

G. J. Cummings
J. H. Francis
Vinton Bacon
Jack W. Pratt
Ira May
Richard P. Lonergan
John Bell
Thomas Gwin
A. J. Pene
John A. Maga
C. F. Reeves
George C. Baker
Norman T. Riffe

L. Cedric Macabee was reinstated in 1940.

We are all glad to know that A. M. Rawn is now Chief Engineer and General Manager of the Los Angeles County Sanitation Districts. C. R. Compton has been advanced to Assistant Chief Engineer and Howard K. Palmer is now Office Engineer of the Districts.

R. R. Ribal is now filling an important position as Principal Assistant Engineer of the East Bay Cities Sewage Disposal Survey.

Dick Pomeroy is in business as a consultant now. He is associated with the firm of Montgomery and Pomeroy.

Many of our members are getting called to service. John A. Clark and Carl Jennings expect to go in the near future.

Harold Farnsworth Gray

Sewage Disposal
Water Purification
Mosquito Abatement
Industrial Sanitation

2540 BENVENUE AVENUE
BERKELEY, CALIFORNIA

Currie Engineering Co.

C. H. CURRIE F. S. CURRIE
D. H. CURRIE

MUNICIPAL AND INDUSTRIAL WASTE ENGINEERING

25 Years Specializing in Water Supply and Sewage Disposal

219 Andreson Building
SAN BERNARDINO, CALIFORNIA

ENGINEERING OFFICES OF

Clyde C. Kennedy

Consulting Engineers

WATER SUPPLY, WATER PURIFICATION
SEWERAGE, SEWAGE TREATMENT, INDUSTRIAL WASTE DISPOSAL AND GENERAL MUNICIPAL IMPROVEMENTS

Inspection and Laboratory Services
SAN FRANCISCO : : : Atlas Building

Western City

SERVING the municipal executives of the Pacific Coast as official publication of the Municipal Leagues of California, Montana, Oregon, Washington and Utah.

AMENDMENTS TO BY-LAWS

To the Members:

The following amendments to the Constitution and By-Laws of the C. S. W. A. were approved by the Governing Board and were passed at the business meeting of the Association, Monday, September 16, 1940, in San Diego.

BY-LAWS.

Article II—Sec. 1. Annual dues shall be two dollars, payable in advance on October 1st, to cover the succeeding fiscal year. Dues are in arrears on February 1st, following the Annual Meeting. *Members residing outside North America shall pay annual dues of three dollars.*

Article II—Sec. 3. Of the annual dues, one dollar and fifty cents shall be paid to the Federation of Sewage Works Associations for membership in the Federation and shall entitle the member to a copy of the Federation publications for the fiscal year covered. *Of the annual dues of members residing outside of North America, two dollars shall be paid to the Federation.*

Changes have been shown *in Italics.*

WILLIAM T. INGRAM,
Secretary-Treasurer, California Sewage Works Association.

AMERICAN CONCRETE
and
STEEL PIPE COMPANY

P. O. Box 3428 Terminal Annex Los Angeles, California

Manufacturers of

HUME CENTRIFUGAL CONCRETE PIPE
LOCK JOINT STEEL CYLINDER PIPE
BELL END CONCRETE SEWER PIPE

For Main Water Supply Lines and Storm and Sanitary Sewer Systems

and

AMERCOAT

A Corrosion-Resistant Protective Coating For Concrete, Steel and Wood

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You Can Do it Better, Faster and More Economically by Welding

Whether the job requires gas or electric welding or cutting, VICTOR will furnish promptly the needed equipments or supplies

Write for the fully illustrated new G. E., 40-page Electrode Bulletin describing all of the latest G. E. electrodes and furnishing interesting and helpful application data.

Write for the **VICTOR** *Gas Welding and Cutting Equipment Catalog*

VICTOR EQUIPMENT COMPANY

844-50 Folsom Street
San Francisco

3821 Santa Fe Avenue
Los Angeles

On Request . . .

We will send you free, copies of our comprehensive *guide to complete success* in meeting every condition of deteriorating concrete or rusting steel in Sewage Treatment Works and Incinerator Plants.

Write today to Dept. 141

★

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SAN FRANCISCO, CALIF.
SUtter 4592

1736 E. 15th St.
LOS ANGELES, CALIF.
PRospect 3178

For Uninterrupted Service

USE

VITRIFIED CLAY SEWER PIPE

AND

Lay to Stay

◆ ◆

N. CLARK & SONS

Manufacturers

Office
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Factory
WEST ALAMEDA
California

To Insure First Cost
Being Last Cost on
Your Sanitary
Sewers

Use...

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CLAY

Pacific Clay Products

306 WEST AVENUE 26

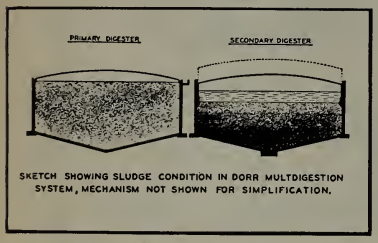
P. O. Box 145—Station A

Telephone CApitol 4281 Los Angeles, California

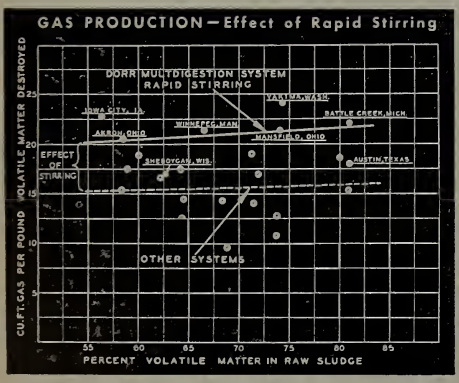
Hagerstown, Md. — A typical Dorr Multdigestion System. Stirred and heated primary tank at left; unheated, plain secondary at right.

POSITIVE PROOF

that SLUDGE STIRRING Pays



SKETCH SHOWING SLUDGE CONDITION IN DORR MULTDIGESTION SYSTEM, MECHANISM NOT SHOWN FOR SIMPLIFICATION.



★ Rapid stirring, secured only in the Dorr Multdigestion System, definitely results in more rapid digestion—in a more completely digested final sludge.

Check over the chart at the left. See how the Dorr Multdigestion Systems are producing up to 1/3 more gas per pound of volatile than others. Remember that gas production is a true indication of the rate of the digestion reaction and its ultimate completeness.

The secret of the widespread success of the Dorr Multdigestion System is rapid stirring and destruction of scum in the primary tank. This means more digestion capacity per cu. ft. of tankage and a more economical and efficient installation for a given job.

● *Write for complete information on the Dorr Multdigestion System which is now serving a population of several millions in more than 60 cities and towns.*

DORRCO

THE DORR COMPANY, INC. • ENGINEERS

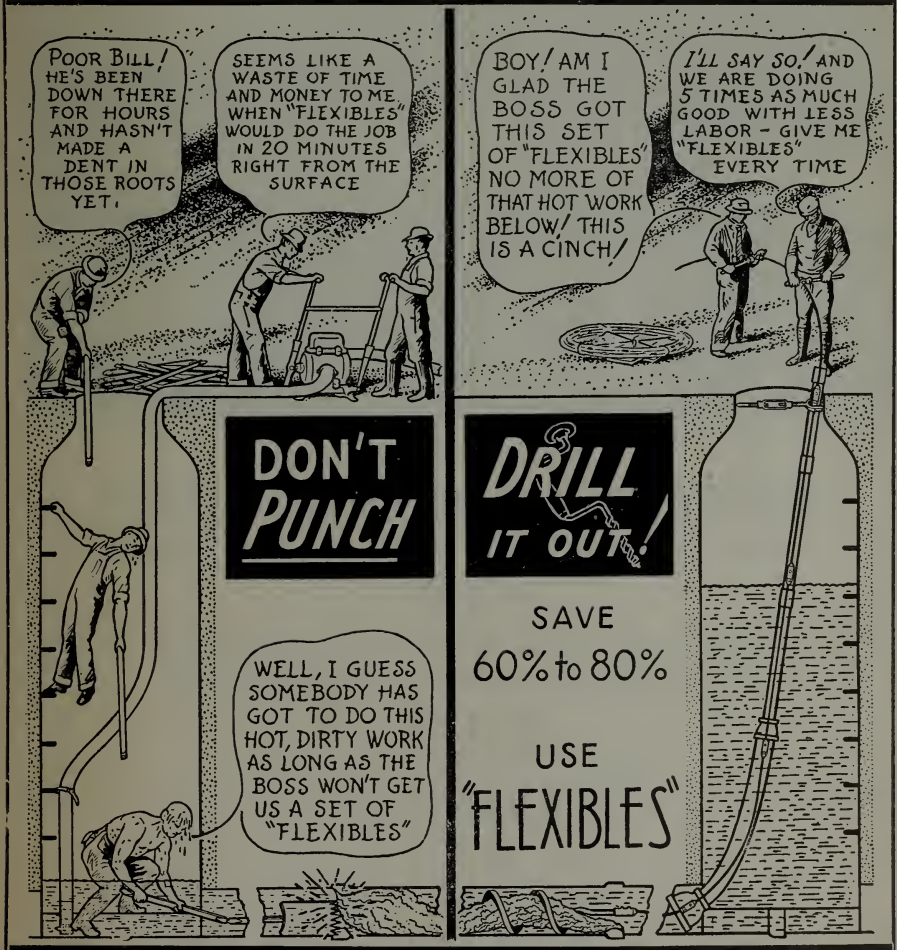
570 LEXINGTON AVE. • NEW YORK

ATLANTA • TORONTO • CHICAGO • DENVER • LOS ANGELES

MODERNIZE YOUR DEPARTMENT

WITH

FLEXIBLES


POOR BILL! HE'S BEEN DOWN THERE FOR HOURS AND HASN'T MADE A DENT IN THOSE ROOTS YET.
SEEMS LIKE A WASTE OF TIME AND MONEY TO ME. WHEN "FLEXIBLES" WOULD DO THE JOB IN 20 MINUTES RIGHT FROM THE SURFACE
BOY! AM I GLAD THE BOSS GOT THIS SET OF "FLEXIBLES" NO MORE OF THAT HOT WORK BELOW! THIS IS A CINCH!
I'LL SAY SO! AND WE ARE DOING 5 TIMES AS MUCH GOOD WITH LESS LABOR - GIVE ME "FLEXIBLES" EVERY TIME
DON'T PUNCH
DRILL IT OUT!
WELL, I GUESS SOMEBODY HAS GOT TO DO THIS HOT, DIRTY WORK AS LONG AS THE BOSS WON'T GET US A SET OF "FLEXIBLES"
SAVE
60% to 80%
USE
"FLEXIBLES"

Write for our New 1941 Catalog and Operation Data Today

Free 30-Day Trial — Unconditional Guarantee

FLEXIBLE SEWER-ROD EQUIPMENT CO.

9059 Venice Blvd. LOS ANGELES, CALIFORNIA

BIO-FILTRATION PLANT

at Veterans Home, Yountville, California

Two Stage Complete Treatment

LINK-BELT STRAIGHTLINE SLUDGE COLLECTORS

Used in Primary and Secondary Retention Tanks

IN 1937

Our Advertisement in the C. S. W. A. Journal Pictured the Camarillo, Calif., State Hospital Sewage Treatment Plant with Caption.

"Something New" — "Bio-Filtration Process"

IN 1940

Over 30 Bio-Filtration Plants

High Plant Efficiency, Low Maintenance Cost and Simplicity of Operation Have Made This Possible.

SEND FOR BIO-FILTRATION FOLDER NO. 1881

LINK-BELT COMPANY

Los Angeles, 361 S. Anderson St. San Francisco, 400 Paul Ave.
Seattle, 820 First Ave., S.—Portland, Ore., 1637 N. W. 14th Ave.—Oakland, 526 3rd St.
PLANTS at San Francisco, Chicago, Indianapolis, Philadelphia, Atlanta and Toronto

LINK-BELT

SCREENS — COLLECTORS — MIXERS — AERATORS — GRIT CHAMBERS

Vitrified Clay Sewer Pipe
Vitrified Clay Liners
Sewer and Acid Brick

•

We Suggested the Use of CPI-401
Sewer Joint Compound

Gladding, McBean & Co.

LOS ANGELES • SAN FRANCISCO • SEATTLE • PORTLAND
SPOKANE • DALLAS • DENVER • HONOLULU, T H.

"VAREC" *Approved* PRODUCTS

Pressure Relief and Flame Trap Assembly • Flame Trap Assembly • Pressure Relief and Vacuum Breaker Valves • Flame Arresters • Waste Gas Burners • Flame Checks • Back Pressure Regulators • Pressure (Reducing) Regulators • Check Valves (Non-Chattering) • Sediment Traps • Drip Traps • Manometers • Pressure (Explosion) Relief Valves • Manhole Covers • Handhole Covers • Sampling Hatches

One of the Hundreds!

Greenville, Michigan

October 11, 1940

The Vapor Recovery Systems Company,
Compton,
California

Gentlemen:

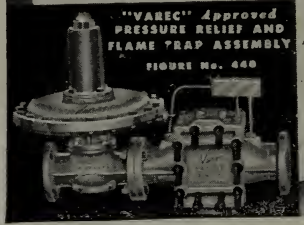
I wish to say the new Unit (Figure 440) which we received some time ago is working perfectly, every part seems to be working and doing a good job, and it is equipment no engineer need be afraid to install as it gives perfect satisfaction in every respect.

May I have a copy of your Handbook and Catalog as mentioned in advertisement in the September issue of Sewage Works Journal.

Very truly yours,

George Edgcombe

George Edgcombe
Operator - Sewage Treatment Plant
Greenville,
Michigan.

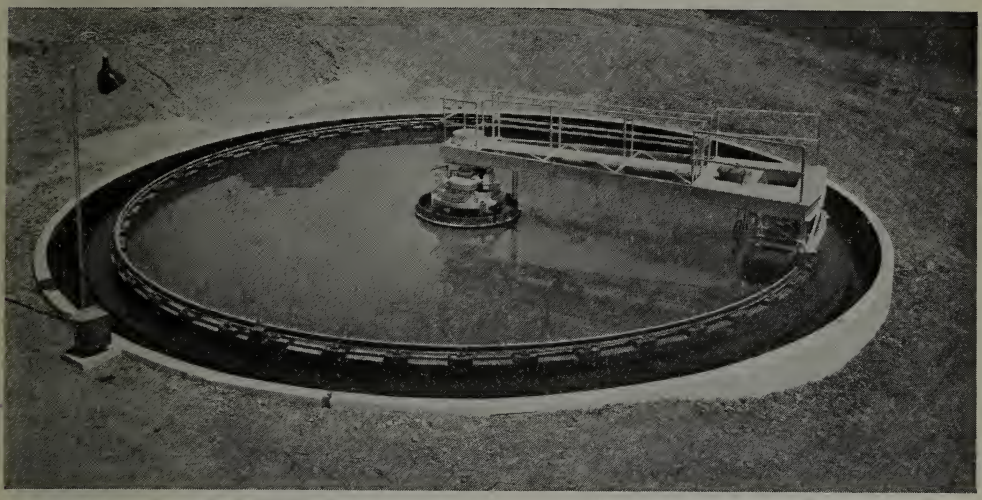


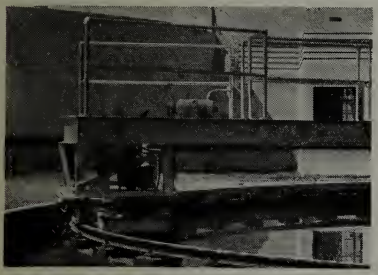
OVER 500 SEWAGE TREATMENT PLANTS

have been equipped with "Varec" Equipment in less than two years.

The VAPOR RECOVERY SYSTEMS COMPANY
• COMPTON • CALIFORNIA •

SONOMA and NEW ULM Select..





TOP: Final Dorr Clarifier at Sonoma with circular Automatic Magnetite Filter around periphery.

ABOVE: Close-up of cleaner element of Automatic Magnetite Filter.

APPLICATIONS

In Plain Sedimentation—Less settling capacity required and a 40% improvement in effluent.

In Chemical Precipitation—50% less chemical consumption; less time for coagulation and settling.

In Activated Sludge—Less settling and aeration tank capacity; less compressed air.

In Trickling Filters—If ahead, less primary settling tank capacity.
If behind, less humus tank capacity.

In Biofiltration Systems—Less final settling capacity required and a better final effluent.

In Industrial Waste Treatment—Better final effluents at lower installation and operating costs.

Automatic
MAGNETITE FILTERS -- TO POLISH HIGH RATE FILTER EFFLUENTS

The model 0.75 M.G D. sewage treatment plant of Sonoma State Home, Eldridge, Cal., consists of a single stage Biofiltration System followed by an Automatic Magnetite Filter. At New Ulm, Minn., this same type of filter is used in conjunction with a Halvorsen System of High Rate Trickling Filters.

The Automatic Magnetite Filter consists of a 3 inch layer of sized magnetite ore, supported on a screen and periodically cleaned by a moving solenoid which alternately lifts and releases a narrow strip of ore. A counterflow of wash water, introduced as the layer is lifted, carries off imbedded fines and renews the life of the bed.

Automatic Magnetite Filters, wherever installed, polish plant effluents to a uniform degree—remove the finest solids at a lower cost per ton than any other device operating over the same range. That, in a nutshell, is why Automatic Magnetite Filters make every type of sewage treatment plant do a bigger and better job.

Write for your copy of the Automatic Magnetite Filter Bulletin

THE AUTOMATIC MAGNETITE FILTER IS MARKETED EXCLUSIVELY BY THE DORR COMPANY, INC.

FILTRATION EQUIPMENT CORP.

10 East 40th Street • Sales Office • New York, N. Y.

Coarse Screens • Automatic Magnetite Filters • Conkey Vacuum Filters

THE END

1

There once lived a man
And his hair was white
He raked the rags
And kept things bright
Down by the end of the sewer.

2

His life was long
And the way was fair
He waxed full fat
With a noble air
Down by the end of the sewer.

3

The longer he lived
The less he did
He learned the art
Of keeping hid
Down by the end of the sewer.

4

There came a time
As always will
When nothing was done
But sitting still
Down by the end of the sewer.

5

It wasn't long
And it isn't strange
Till everyone knew
Of his limited range
Down by the end of the sewer.

6

This tale is short
As you may know
For this old man
Does no longer go
Down by the end of the sewer.

7

The moral is clear
And the treatment fair
There's another old man,
A new man there
Down by the end of the sewer.

—*Pensor.*

What'll we do?

Our water supply is polluted . . . and it connects with the city mains!

HUNDREDS of thousands of citizens were in danger. The distribution system of a great city was interconnected at one point with a private water supply . . . and the latter had become dangerously polluted!

A steel piling driven into the ground had shattered a pressure sewage main. Sewage flowed into a private water system which was cross connected to the municipal water supply. There was no sure way to determine whether any of the polluted water had reached the city mains . . . but there *was* a quick, dependable method right at hand to sanitize the supply. The municipal plant was amply prepared with Perchloron!

Perchloron, solution barrels, and a pump were immediately loaded on a water works truck and set up at a fire hydrant near the potential source of pollution. Perchloron solution was pumped into the city main, providing emergency chlorination that protected the population against danger.

That is an instance of the way Perchloron fits in. Plants in every section of the country have found how well it pays to be prepared with Perchloron. They use it, not only for emergency chlorination, but for sanitizing new mains, for clear wells and filters, and for swimming pool sanitation.

Perchloron, a dry, free-flowing granular material, contains more than 70% available chlorine. It is stable, concentrated, uniform. Ready-to-use solutions are quickly prepared by dissolving it in tap water. Packed 9 handy-sized cans to the case, each can with Kork-N-Seal cover. Also in 100-lb. drums. Write for free booklet. Pennsylvania Salt Manufacturing Company of Washington, 2901 Taylor Way, Tacoma, Washington.

Perchloron

PENNSYLVANIA SALT
MANUFACTURING CO. OF WASHINGTON
Chemicals
TACOMA, WASHINGTON

AT BUFFALO

Another Outstanding Sewage Disposal Plant

and AGAIN the Chlorinators are by W&T

Thirty thousand pounds of chlorine per day—automatically controlled by five-6000 pounds per day W&T VISIBLE VACUUM CHLORINATORS, makes this one of the world's outstanding chlorinator installations.

Five electrically operated W&T Recorders make constant records of the chlorine flow, indicating changes that follow changing sewage volume and totaling the daily chlorine consumption.

An outstanding chlorinator installation—Yes! But, more than that, an indication that the other 20,000 W&T installations have given a degree of satisfactory service that leads the Buffalo authorities to believe they make no mistake in trusting this job to W&T.

No matter how small—No matter how large your prospective chlorinator installation is—talk to us about it.

WALLACE & TIERNAN CO., Inc.

MANUFACTURERS OF CHLORINE AND AMMONIA CONTROL APPARATUS

Newark, New Jersey **Branches in Principal Cities**